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OPHTHALMOLOGY AND OTOLOGY

A MANUAL
OF
OTOLOGY.

BY

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PREFACE TO THE SEVENTH EDITION.

THE demand for a new edition of this Manual proves that it is still fulfilling its original purpose as a textbook for students and a compact book of reference for the busy general practitioner, and this naturally is a source of much gratification to the author. The work has been thoroughly revised, and about forty pages of new matter and illustrations have been added. The author is indebted to his associate, Dr. Truman Laurance Saunders, who has revised the chapter on adenoid growths, enlarged tonsils and the submucous resection of the nasal septum. The description of catarrhal affections and polypi of the nose and nasopharynx has been omitted in this edition in order to keep the Manual a convenient size, and also because the author feels that these subjects belong more properly in a textbook on rhinology. The text dealing with the suppurative inflammation of the labyrinth has been entirely rewritten by Dr. Saunders, and a number of new pages and illustrations have been added. Careful consideration has been given to this most important subject, and especial emphasis has been laid upon the symptoms and diagnostic tests of labyrinthine involvement. Included in this chapter are the ear tests required by the United States government for candidates for the

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aviation service. The author wishes to express his thanks to his friend, Dr. George Sloan Dixon, for his help in the work of revision.

G. B.

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MANUAL OF OTOLOGY.

CHAPTER I.

ANATOMY AND PHYSIOLOGY OF THE EAR.

In order to study the anatomy and physiology of the ear in a satisfactory manner, the organ of hearing is divided into (I.) the sound-conducting and (II.) the sound-perceiving apparatus.

I. The sound-conducting apparatus includes
  a. The external ear, consisting of
    1. The auricle (or pinna) and
    2. The external meatus (or external auditory canal).
  b. The middle ear, composed of
    1. The tympanum (or tympanic cavity), with the membrana tympani and the ossicles,
    2. The Eustachian tube, and
    3. The mastoid process.

II. The sound-perceiving apparatus (or internal ear) comprises
    1. The vestibule,
    2. The semicircular canals, and
    3. The cochlea.

The latter receives the peripheral expansions of the auditory nerve, the excitation of which produces in the brain-centre sensations which we call sound.

(*a*) THE EXTERNAL EAR.

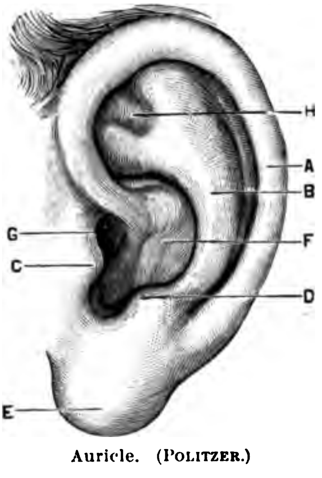
The external ear consists of

1. The auricle (or pinna) and
2. The external meatus (or external auditory canal).

1. The Auricle.

The auricle, or pinna, pyriform in shape, is attached to the side of the head by means of ligaments and muscles. It usually forms an acute angle with the lateral portion of the head, although the angle varies in different individuals. The auricle is composed of yellow or reticulated cartilage, except the lower portion, called the lobule, which is formed mostly of connective tissue, in the meshes of which are globules of fat. The lobule

Fig. 1.



Auricle. (Politzer.)

A. Helix. B. Antihelix. C. Tragus. D. Antitragus. E. Lobule. F. Concha. G. Orifice of the external meatus. H. Fossa of the antihelix or fossa scaphoidea.

contains but few bloodvessels and nerves. The cartilage of the auricle, about $\frac{1}{10}$ inch in thickness, is covered by the perichondrium, and outside of the perichondrium is the integument. The latter is more firmly attached to the anterior than to the posterior surface of the cartilage. The anterior or concave portion of the auricle presents a number of ridges and depressions.

The helix (see Fig. 1, A) begins just above the external meatus at a point in the concha called the crista helicis, and extends upward, backward, and downward, and terminates just above the upper portion of the lobule.

The antihelix (B) is another elevation running in a parallel direction with the posterior portion of the helix. It starts by means of two crura above the crista helicis, and, passing backward and downward, terminates in the antitragus, D. Partly closing the external opening of the ear, and opposite the antitragus, is the tragus, C. Between the tragus and the antitragus is a depression called the incisura intertragica. The fossa of the antihelix, or fossa scaphoidea (H), lies between the two crura of the antihelix. There are a few sebaceous glands in the lobule, but they are much more numerous and of larger size in the concha.

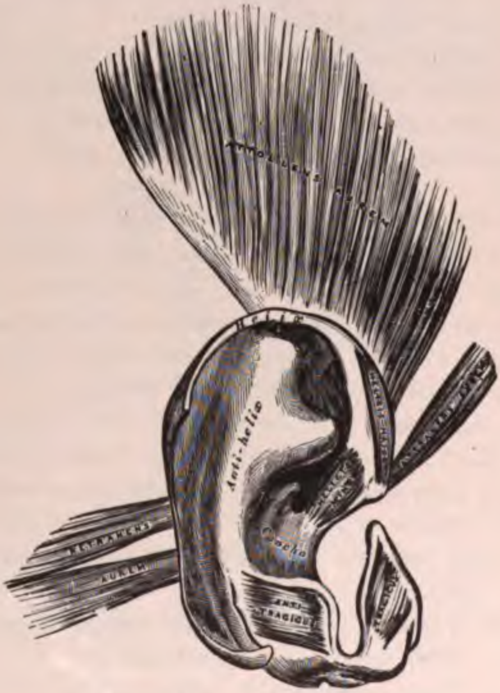
There are two sets of muscles connected with the auricle. The first set consists of the

1. Attollens aurem, which takes its origin from the epicranial aponeurosis, and is inserted into the upper convex surface of the auricle. Its action is to support and pull the auricle upward.

2. Attrahens aurem, which also arises from the epicranial aponeurosis, is attached to the crista helicis. It draws the auricle forward and upward.

3. Retrahens aurem, which has its origin from the mastoid process, is inserted into the posterior convex surface of the concha. This muscle pulls the auricle backward, but the action of all these three muscles is

FIG. 2.



The muscles of the pinna. (GRAY.)

very limited. Some persons, however, have the power of moving their ears quite perceptibly.

The second set of muscles, five in number, are muscular fibres lying on the concave and convex surfaces of the auricle (see Fig. 2), and are called the

1. Tragicus.	On the concave surface.
2. Antitragicus.	
3. Helicis major.	
4. Helicis minor.	
5. Transversus auriculæ.	On the convex surface.
6. Obliquus auris.	

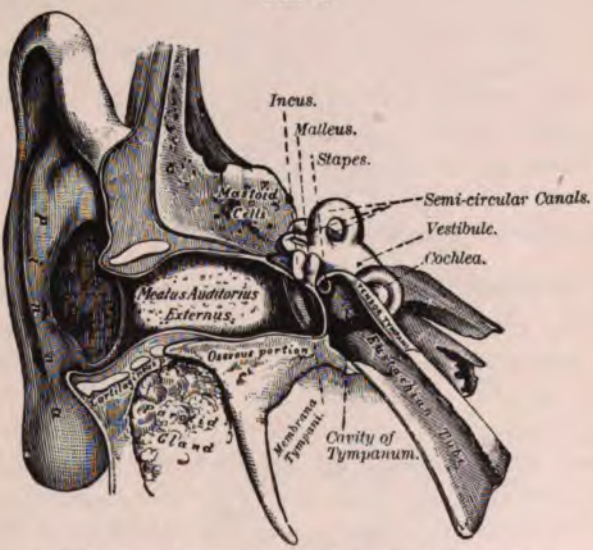
These muscles are rudimentary in man, and have very little action.

There are also various ligaments, some holding the auricle to the side of the head and others connecting the different portions of the cartilage together.

2. The External Meatus, or the External Auditory Canal.

The external meatus, about one inch and a quarter in length, is a continuation inward of the auricle, and consists of a cartilaginous and a bony portion. The cartilaginous portion is not cartilaginous throughout its whole extent, the cartilage being wanting in the upper and posterior portions of the canal, where a membranous layer attached to the lining membrane of the canal takes its place (Fig. 3). The fissures of Santorini, generally two in number, are situated in the lower and anterior wall of the cartilaginous meatus. These fissures, transverse to the long axis of the canal, are openings in the cartilage which are filled in with fibrous tissue, and are of importance to the aural surgeon, because in examinations of the ear they allow a certain straightening of the meatus, and, further, an inflammation of the external auditory canal may extend to the parotid gland through these fissures, and, *vice versa*, in case of parotiditis leading to the formation of an abscess, the pus may force its way through these openings into the external meatus and give rise to an otorrhœa, the source of which can only accurately be determined by means of the head-mirror and speculum.

FIG. 3.

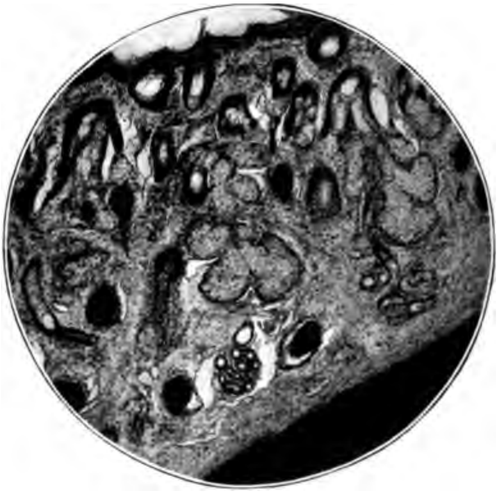


A front view of the organ of hearing. (Right side.) (GRAY.)

The Osseous Meatus.

The osseous meatus, forming about two-thirds of the entire external auditory canal, consists of a bony ring in the infant (the annulus tympanicus) (Fig. 5, C), which develops later in adult life into a bony canal about three-quarters of an inch in length. In the infant the tympanic ring is attached to the squamous portion of the temporal bone by its two extremities, between which is a space which, later, becomes the Rivinian segment, and connected with this ring is a membranous canal. Occasionally, in the fully developed temporal bone fissures are observed in the upper and posterior walls of the bony meatus. As prolongations of connective tissue extend into these fissures, it is easy to understand how inflammatory material may pass through these openings and cause caries of the walls of the canal. The cartilaginous canal contains soft hairs and sebaceous and ceruminal glands. A few of the latter are found in the bony portion, especially in its upper wall, and occasionally they have been found to extend as far as the drum-membrane. The lining membrane of the external meatus is simply a continuation inward of the integument of the auricle, and is not a mucous membrane, as formerly was supposed. The dermal layer in the bony portion is very thin and closely attached to

FIG. 4.



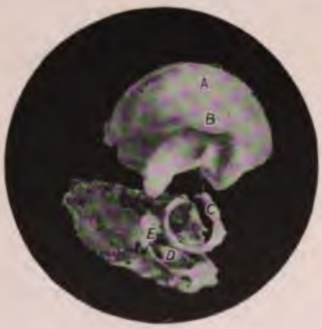
Photomicrograph of a transverse section of the cartilaginous external auditory canal at birth.

the periosteum, a fact which accounts for the excruciating pain sometimes observed in acute inflammation of the lining of the external meatus.

The blood-supply for the auricle and external meatus comes from the temporal and internal maxillary arteries.

The anterior or concave surface of the auricle and the outer portion of the external meatus derive their supply from several branches of the superficial temporal artery. The posterior surface is supplied by a branch of the posterior auricular artery (a branch of the external carotid). The inner portion of the external meatus is supplied by the deep auricular artery (a branch of the internal maxillary artery). The smaller branches of these arteries reach the deeper portions of the external meatus by passing through

FIG. 5.



Temporal bone at birth.

A, squama; B, zygoma; C, annulus tympanicus; D, promontory with foramen rotundum; E, foramen ovale.

1. The fissures of Santorini.
2. Through the fibrous connective tissue which joins the cartilaginous canal to the bony canal, and

3. Through the intermediate membranous layer which covers the margins of the cartilaginous groove.

They form a network of capillary vessels on the perichondrium and about the hair-sacs and sebaceous glands. These vessels are quite numerous about the upper border of the membrana tympani and extend along the posterior portion of the handle of the malleus to its inferior extremity.

The veins supplying the two surfaces of the auricle join the external jugular and mastoid veins, although in some cases there are veins that empty into the internal maxillary and temporal veins. Very little is known about the lymphatics of the ear.

The nerves distributed to the auricle and external meatus are derived

1. From the deep posterior auricular nerve (a branch of the facial), which supplies the posterior surface of the auricle.

2. From the cervical plexus through the auricularis magnus.

3. From the auriculo-temporal (a branch of the trigeminus), which supplies the skin of the auricle and external meatus.

4. From Arnold's nerve (a branch of the pneumogastric), which supplies the lining membrane of the external meatus.

In children, one of the difficulties in the way of a successful examination of the external meatus is the small size of the cartilaginous portion. The size and shape of the external meatus in the adult are subject to great variations. In some persons the cartilaginous canal is very wide, while in others it is extremely narrow. The diameter of the canal, which just inside of the external orifice is about $\frac{2}{10}$ to $\frac{3}{10}$ inch at first, becomes wider in its passage inward, and then narrows again at the point of junction with the bony canal where over-development of the auditory process may cause considerable constriction. From this point toward the membrana tympani the bony canal becomes wider. The narrowest part of the bony canal is called the *isthmus*. It is here that foreign bodies are apt to become wedged, while if they pass beyond this constriction it is sometimes impossible to remove them without displacing the auricle forward, an operation to be described later. The distance from the anterior margin of the membrana tympani to the isthmus is about $\frac{6}{20}$ to $\frac{7}{20}$ inch, while the distance from the posterior margin of the drumhead, along the posterior wall to the isthmus is but $\frac{1}{20}$ to $\frac{2}{20}$ inch. This fact should be borne carefully in mind in the case of impaction of a foreign body, which becomes lodged at this point, for serious injury may be done to the drumhead by means of instruments passed along the posterior wall. The cartilaginous canal, in passing inward, turns backward and upward, while the bony canal extends forward and downward. In examining the ear, after introducing the speculum, the auricle should be pulled upward and backward, in order to straighten the external meatus and thus afford a better view of the drumhead.

(*b*) THE MIDDLE EAR.

The middle ear, as previously mentioned, consists of

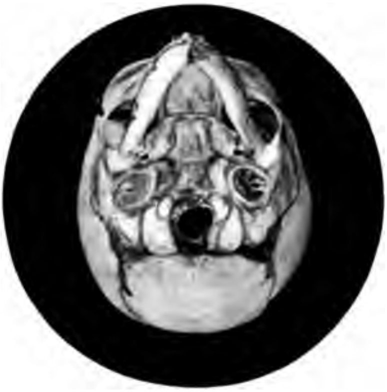
1. The tympanum, or tympanic cavity, with the membrana tympani and ossicles,

2. The Eustachian tube, and
3. The mastoid process.

1. The Tympanum, or Tympanic Cavity.

The tympanum, or tympanic cavity, is very irregular in shape. Its greatest diameters are those extending antero-posteriorly and supero-inferiorly. The membrana tympani, or drumhead, forms the outer wall of the tympanum, together with the inner end of the superior wall of the external auditory canal, and lies at the inner extremity of the bony auditory canal, being placed almost in a horizontal position in the infant at birth (Fig. 5), and gradually becoming more perpendicular in the adult. The membrana tympani receives the sound-waves from the external air and carries them by means of the ossicular chain to the labyrinth. The drumhead in the adult is placed

FIG. 6.



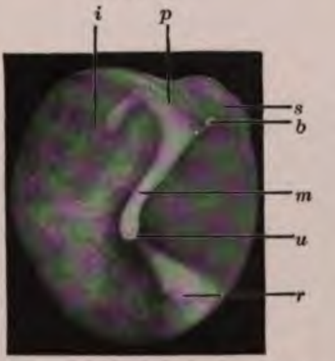
Base of fœtal skull. Right membrana tympani intact. Left one removed, showing ossicles.

obliquely with the long axis of the bony canal, so that the inferior and the anterior walls of the auditory canal are longer than the superior and posterior walls, an important point to be remembered in the extraction of foreign bodies and in other instrumental manipulations. The membrana tympani at its margin is attached to the groove in the bony canal, called the *sulcus tympanicus*, which belongs to the tympanic ring. At the Rivinian segment, previously mentioned, the drumhead is attached partly to the margo tympanicus and partly to the lining membrane of the bony auditory canal. The normal drumhead is of a pearl or grayish color, somewhat oval in shape and drawn inward, the greatest point of concavity being at the *umbo*, at which point the inferior extremity of the malleus is attached by being enclosed in the layers of the drumhead. (See Fig. A, Plate I.) There is a partial convexity or bulging out of the membrana in its anterior and inferior segments, so that the drumhead, while concave as a whole, is convex from the centre to the periphery. The membrana, which resembles goldbeater's skin in appearance, consists of three layers:

1. An external or dermal,
2. A middle or fibrous (lamina propria), and
3. An inner or mucous layer.

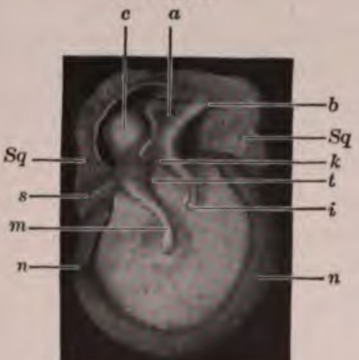
The long handle of the malleus lies between these layers and extends downward to the umbo. The short process is recognized as a short, teat-like projection, and is a most important landmark in examinations of the drumhead. Situated just in front of and behind this process are two folds, which are very important, for it will be demonstrated in another chapter that when the drumhead is drawn inward these folds stand out very prominently. There are two striæ, first

FIG. 7.



Outer surface of the right tympanic membrane of an adult (Politzer). *b*, short process of the malleus; *m*, manubrium or long handle of the malleus; *u*, umbo; *s*, Sharpnell's membrane; *p*, posterior fold of the membrana tympani; *i*, long process of the incus; *r*, reflex of light.

FIG. 8.

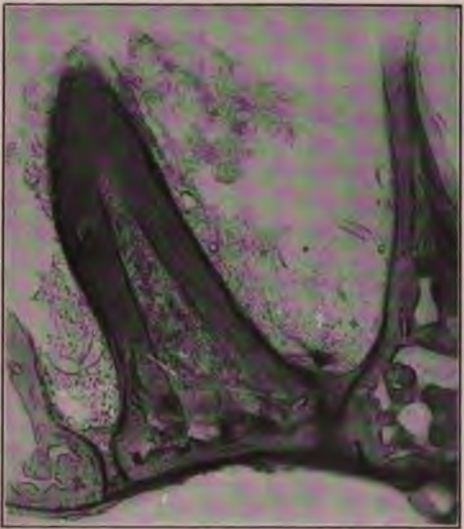


Inner aspect of the right drum membrane (Politzer). *c*, head of malleus; *m*, long handle of malleus; *a*, incus; *b*, short process of the incus; *i*, long process of the incus; *s*, processus gracilis of the malleus; *t*, posterior fold of the drum membrane; *k*, chorda tympani; *n*, *n*, annulus tympanicus; *Sq*, squamous portion of the temporal bone.

described by Prussak, which lie just inside of the two folds, and which can often be made out in life as two tendinous bands. These striæ, together with the grooveless fissure, bound a triangular-shaped portion of the membrane called the *membrana flaccida* or *Shrapnell's membrane* (Fig. 7, *s*). This membrane consists of very delicate and loosely arranged fibres of connective tissue, crossing each other irregularly, and covered by a thin dermic layer on the outer and a mucous layer on the inner surface, and is very much thinner than the other portions of the membrana tympani. The inner lining of the membrana tympani is a continuation of the mucous membrane of the tympanum. The outer or dermal layer is a continuation inward of the skin covering the external meatus, and contains several strata of pavement epithelium. The middle layer, or lamina propria, consists of two sets of fibrous tissue. The outer fibres are attached to the tip of the malleus and radiate toward the circumference, while the inner fibres are circular in their arrangement. As previously stated, a network of vessels descends behind the long handle of the malleus, and at the centre of the drumhead there is a communication between these arteries and veins with a vascular zone which is situated at the periphery of the membrana, and through this latter zone with the vessels of the middle ear.

The superior wall or roof of the tympanum consists of a thin plate of bone, upon which the middle lobe of the brain rests. In the infant there is a suture (petroso-squamosal suture) in the tympanic roof, through which connective-tissue processes with bloodvessels pass from the dura into the middle ear, a fact which explains why an acute inflammation of the middle ear in an infant is apt to occasion more or less meningeal irritation. In the adult this suture is generally closed, but in some temporal bones the delicate superior wall is defective, there being several openings, an anomaly which is designated by Hyrtl as spontaneous dehiscence of the tegmen tympani, and is in all probability due to an arrest of development. The inferior wall is much narrower than the superior, and close to it is the *fossa jugularis.* The proximity of this fossa to the middle ear should be remembered, because phlebitis and thrombosis of the jugular vein are complications liable to follow an inflammation of the tympanic cavity.

FIG. 9.



Section of foot-plate of stapes—foramen ovale, showing ligamentous attachment.

The inner wall separates the middle ear from the labyrinth or inner ear, and presents several points of interest in

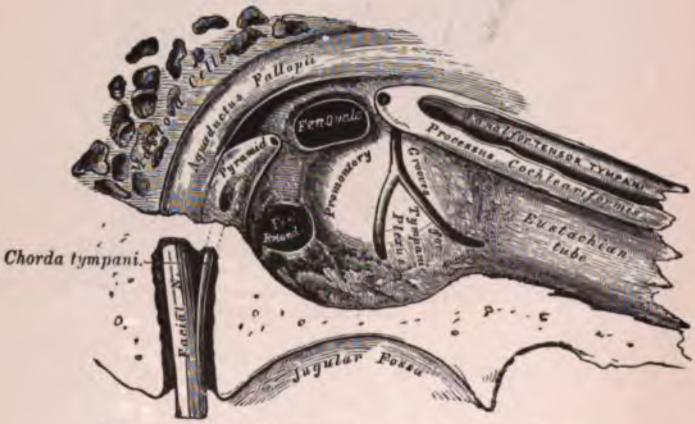
1. The promontory, which corresponds to the first turn of the cochlea;

2. The fenestra ovalis (see Fig. 9), which contains the foot-plate of the stapes, and which lies a little above and behind the promontory; below the fenestra ovalis is

3. The fenestra rotunda, closed by a membrane (membrana tympani secundaria). Behind these foramina are seen (Fig. 10);

4. The pyramid, a cone-shaped projection containing the stapedius muscle, and

FIG. 10.



View of inner wall of tympanum. (Enlarged.) (GRAY.)

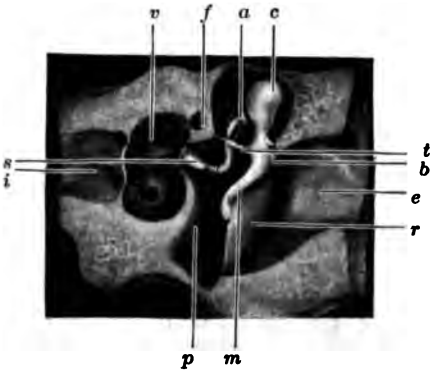
5. The aqueductus Fallopii, enclosing the portio dura, or facial nerve, a slight ridge of bone lying along the upper and posterior part of the inner wall. The facial nerve emerges at the stylomastoid foramen.

The upper portion of the tympanic cavity, which contains portions of the malleus and incus, is called the attic.

The mastoid antrum, the largest of the mastoid cells, communicates with the attic by means of the aditus ad antrum. The short process of the incus lies in the inferior angle of the antrum.

In the anterior wall of the middle ear the bony Eustachian canal is situated. The carotid artery also is in close proximity to the anterior wall, so that in cases of caries or necrosis fatal hemorrhage may occur. The *tensor tympani muscle* lies in a bony canal just above and parallel with the Eustachian tube, and, passing around the processus cochleariformis, is attached to the upper and posterior part of the handle of the malleus.

FIG. 11.



Right ear (Politzer), *e*, external auditory canal; *r*, membrana tympani; *c*, head of the malleus; *b*, short process of the malleus; *m*, long process of the malleus; *a*, incus; *s*, stapes; *t*. tendon of tensor tympani muscle; *p*, promontory; *f*, fallopian canal; *v*, vestibule; *i*, internal auditory meatus.

The Ossicles.

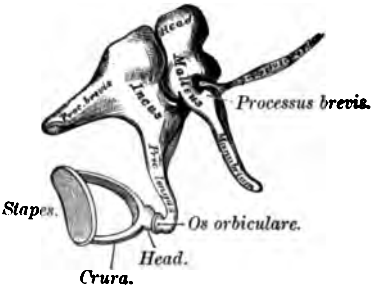
The ossicles consist of the malleus, incus, and stapes. The malleus has

1. A head which articulates with the incus.
2. A short process (processus brevis), and
3. A long process or handle, or manubrium, and (Fig. 12).
4. A processus gracilis.

The incus, besides

1. The body, which resembles the crown of a molar tooth, has
2. A long process (processus longus), which articulates with the head of the stapes, as well as
3. A short process (processus brevis).

FIG. 12.



The small bones of the ear, seen from the outside. (Enlarged.) (GRAY.)

The latter is attached by a fan-shaped ligament to the lower angle of the mastoid antrum.

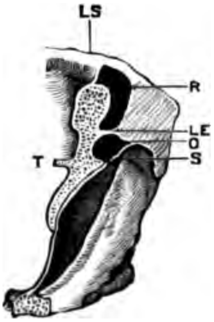
As its name implies, the stapes is shaped like a stirrup. Besides the head, already mentioned, which articulates with the incus, there are two

1. Crura, and
2. A foot-plate, the latter being attached to the foramen ovale by means of the annular ligament.

The *chorda tympani nerve* (see Fig. 95) enters the tympanum through a small canal at the posterior border of the membrana tympani, and, passing between the long process of the incus and the handle of the malleus, emerges at a small opening (canal of Huguier) close to the anterior border of the drumhead and at the inner extremity of the Glaserian fissure. It then passes down between the two pterygoid muscles, and meeting the lingual nerve accompanies it to the submaxillary gland.

The articular portions of the ossicles are connected together by capsular ligaments. In addition to these there are numerous ligaments between the ossicles and the tympanic cavity. The external ligament of the malleus should be mentioned, as it forms the upper boundary of *Prussak's space.* The other boundaries of

FIG. 13.



Prussak's space, section through the tympanic membrane, malleus, upper and outer tympanic wall of a decalcified preparation. (POLITZER.)

LS. Superior ligament of the malleus. LE. External ligament of the malleus. S. Shrapnell's membrane, or the membrana flaccida. O. Prussak's space. R. System of cavities between the body of the malleus and the incus and the external tympanic wall. T. Tendon of the tensor tympani muscle.

this cavity, as shown in Fig. 13, are, internally, the neck of the malleus; below, the superior surface of the short process of the malleus, and, externally, the membrana flaccida, or Shrapnell's membrane. The conjoined bones, viz., the malleus and incus, serve to divide the attic into two compartments. The *outer compartment* or *external attic*, is situated between the articulating bones and the outer bony wall, being bounded above by the superior ligament of the malleus and the superior malleo-incudal fold. This *external attic* is further subdivided into a *superior* and *inferior cavity* (see Fig. 13), the latter being known as Prussak's space, and being bounded superiorly by the external ligament of the malleus and the system of cavities described by Politzer; internally, by the neck of the malleus; inferiorly, by the short process of the malleus; and externally, by the membrana flaccida. Prussak's space communicates with the upper part of the attic, and also with the posterior portion of the tympanic cavity by a small opening.

A good understanding of the subdivisions of the attic is most important to the aurist, for it is here that the inflammation of the middle ear is occasionally most marked, leading frequently to caries of the walls and of the ossicles.

The origin of the tensor tympani muscle is

1. From the cartilaginous portion of the Eustachian tube.

2. From the osseous wall of the pyramid close to the carotid canal, and

3. From the bony canal through which it passes.

The tendon curves around a bony process, the processus cochleariformis (see Fig. 10), and is inserted into the upper and posterior portion of the long process of the malleus.

The stapedius muscle arises from the bony pyramid through which it passes, and the tendon is inserted into the neck of the stapes (Fig. 96).

Experiments made by Politzer upon dogs proved

1. That the tensor tympani is supplied by the motor portion of the fifth nerve, and
2. That the central fibres of the stapedius muscle are under the control of the facial nerve.

The lining membrane of the middle ear is quite thin, and its epithelium is of the ciliated squamous variety in the upper part of its cavity, while in the lower portion it is ciliated cylindrical. The connective tissue which contains the bloodvessels and nerves serves as a periosteum, and the mucous membrane of the tympanum is a continuation inward of the mucous membrane of the pharynx and Eustachian tube. There are various folds of mucous membrane between the walls and the ossicles. In the newborn infant the lining membrane of the tympanum contains a great many bloodvessels and has a swollen appearance. During fœtal life the tympanum is filled with a gelatinous mass, which degenerates rapidly after birth into a thick fluid, owing to the entrance of air into the middle ear. This fluid becomes absorbed.

The arteries supplying the tympanum are

1. The tympanic, from the internal maxillary.
2. Several branches from the middle meningeal.
3. A few branches from the internal carotid.
4. The ascending pharyngeal (a branch of the external carotid), and
5. The stylomastoid artery.

The veins supplying the tympanum communicate with those of the external meatus as well as with the plexus in the carotid canal and the plexus of the lower jaw, and further join the veins of the dura mater by passing through the petrososquamosal suture. Anatomical investigations undertaken by Politzer prove that "vascular connections are kept up between the middle ear and the labyrinth through the osseous wall separating them." This point is of importance, because it is easy to understand how involvement of the labyrinth may occur simultaneously with acute inflammation of the middle ear.

The nervous supply is derived from

1. The sympathetic.
2. Sensory fibres of the trifacial, and
3. The glosso-pharyngeal.

Jacobson's nerve, the tympanic branch of the glosso-pharyngeal, enters the tympanic cavity through a small canal in the inferior wall of the jugular fossa, and joins, at the promontory, the small superficial petrosal nerve.

The tympanic plexus lying on the inner wall of the middle ear is composed of

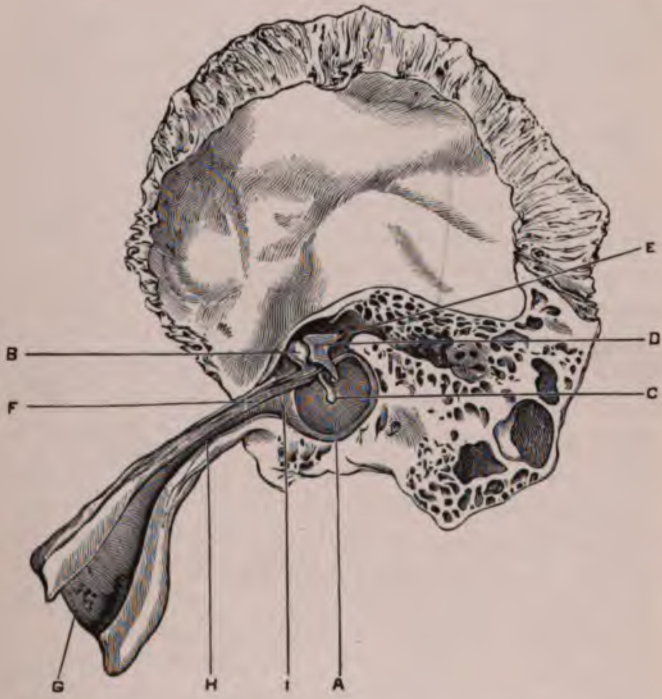
1. Branches of Jacobson's nerve.
2. The small superficial petrosal nerve, and
3. Branches from the carotid plexus.

This plexus distributes branches to the fenestra ovalis, the fenestra rotunda, and the lining membrane of the middle ear and Eustachian tube.

2. The Eustachian Tube.

This tube is named after Eustachius, who described it more minutely than other writers, although Vesalius had previously discovered it. It is the passage connecting the middle ear with the pharynx, and through it the external air enters the tympanum. It is about one and one-half inches in length. The position of the tube is oblique, extending from the tympanum forward, downward, and inward, while its axis forms an angle of 135° with the horizontal axis of the meatus. It is wider at either extremity than at the junction of the cartilaginous and osseous portions, and is composed of a bony and a cartilaginous canal (Fig. 14).

FIG. 14.



Eustachian tube and tympanic cavity. (POLITZER.)

A. Membrana tympani. B. Head of the malleus. C. Lower end of the handle of the malleus. D. Body of the incus. E. Short process of the incus. F. Tensor tympani muscle. G. Pharyngeal opening of the tube. H. Isthmus of the tube. I. Tympanic opening of the tube. (Right ear.)

The *osseous canal*, a continuation inward of the anterior portion of the tympanic cavity, is bounded externally by the tympanic bone, superiorly by the canal of the tensor tympani, inferiorly and to the inner side by the canal for the carotid artery. The average diameter of the tube is about $\frac{1}{12}$ inch, although the greatest diameters vary from $\frac{2}{12}$ to $\frac{3}{12}$ inch, while its smallest normal calibre is large enough ordinarily to admit a small probe.

The *cartilaginous canal*, about two-thirds the whole length of the tube, is attached at its upper end by connective tissue to the irregular margin of the bony canal, and has a funnel-shaped opening into the nasopharynx. The canal is not composed throughout of cartilage, being partly cartilaginous and partly membranous. The posterior and upper walls are cartilaginous. The membranous portion forms the lesser half of the circumference of the tube, while the cartilaginous portion forms the boundary of one side and the superior wall. The calibre of the tube is slightly sigmoid and cleft-like in shape. The cartilaginous portion is stiff enough to prevent complete closure of the lumen of the canal, although the opposite surfaces of the lining membrane touch one another except at a point very near the union of the cartilaginous and bony portions and at the pharyngeal orifice. The cartilage is composed superficially of a hyaline, but in the deeper part of a fibrous, fundamental substance. Zuckerkandl and Urbantschitsch describe numerous irregular fissure-clefts in the cartilage, and occasionally a division of the cartilage into several separate portions. The opening of the tube in the nasopharynx lies on the external wall of the latter, just behind the posterior extremity of the inferior turbinated bone, being rounded in the child, but oval-shaped in the adult. The Eustachian tube in children is much wider and shorter, its direction is more horizontal, and it contains less cartilage than in the adult; the opening also into the tympanum is larger, while the pharyngeal orifice is much smaller, and it is easier to inflate the middle ear in children than in adults, while the secretion passes more readily from the middle ear to the pharynx. The mucous membrane lining the Eustachian tube is of a light-yellow color, and projects somewhat at the pharyngeal opening, but is firmly adherent to the deeper tissues. It is of the ciliated cylindrical variety, the cilia moving in a direction from the tympanum toward the pharynx, thus aiding the flow of mucus or of fluid from the middle ear or tube toward the pharynx. The mucous membrane in the cartilaginous portion is more fully developed than in the bony portion, and contains many acinose glands. In the bony portion there are but few of these glands, and the membrane is very thin, smooth, and closely adherent.

The tensor palati and levator palati are the muscles that open the tube during the act of swallowing, and thus favor the passage of air toward the tympanic cavity. The tensor palati has its origin from (1) the under surface of the sphenoid, from (2) the extremity of the cartilaginous hook, and also from (3) the membranous wall of the cartilaginous portion of the tube. Passing downward around the hamulus pterygoideus, it spreads out in the fibrous prolongation of the hard palate. The tendon being quite firmly attached to the hamulus pterygoideus, it acts more fully on the Eustachian tube than on the soft palate when the muscle contracts. Its action on the tube is to separate the outer or membranous wall, together with the cartilaginous hook, from the inner wall.

The levator palati arises from the surface of the petrous bone adjoining the carotid canal. In its course parallel to the Eustachian tube it is joined by some connective-tissue fibres to the membranous portion which forms the base of the tube, and also to the cartilaginous plate, and is inserted below the pharyngeal opening of the tube into the soft palate. The action of this muscle seems to increase the transverse diameter of the cartilaginous canal by pulling the lower wall of the tube upward and backward.

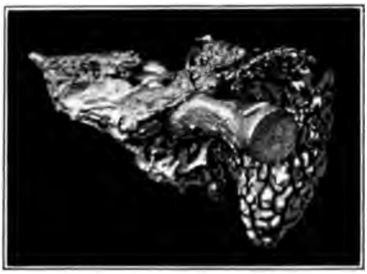
The arterial supply is derived from (1) the pharyngeal, a branch of the external carotid artery; (2) the middle meningeal, from the internal maxillary artery, and (3) some small branches from the internal carotid artery. The veins are numerous, and form a plexus which communicates with the cavernous sinus and with the plexus near the temporomaxillary articulation, and empty into the facial or internal jugular veins.

The tensor palati muscle derives its nervous supply from the otic ganglion and from the internal pterygoid nerve, which is a branch of the inferior maxillary nerve. The levator palati is supplied by a branch of the pneumogastric and by the facial through the Vidian and petrosal nerves.

3. The Mastoid Process.

The mastoid process under normal conditions communicates with the posterior and upper part of the middle ear by means of the antrum, the aditus ad antrum, and the attic. In the light of anatomical investigations we know that no two mastoid processes are exactly alike. According to Zuckerkandl, who made an examination of one hundred mastoid processes in the fresh state and of one hundred and fifty macerated ones, there were absolutely no air-cavities in 20 per cent. of the specimens. Of the entire number, 38.6 per cent. were perfectly pneumatic mastoid processes without diploëtic spaces. He found also that in some persons only the upper half of the process was pneumatic, while the lower half was diploëtic. It will thus be seen that there are three different kinds of mastoid processes: (*a*) the pneumatic, (*b*) the diploëtic, and (*c*) a mixed variety or a combination of the two. In the pneumatic variety (see Figs. 15, 18 and 121), very frequently numerous cellular spaces are found extending into the temporal bone in different directions—viz., around the lateral sinus, down to the apex, backward to the occipital suture, and upward toward the root of the zygoma—(see Fig. 16), a point to be remembered in operations on the mastoid, for it is most important in such cases to remove thoroughly

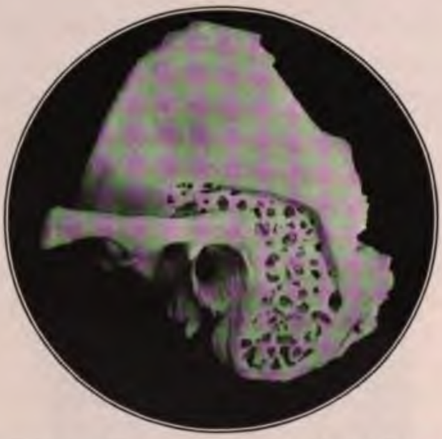
FIG. 15.



Wood's metal corrosion cast of left temporal bone, prepared by E. B. Burchell.

all diseased tissue found in these cells. In an infant at birth there is usually found but one cell, the *antrum*, and the mastoid process is but a small tuberosity and undeveloped. From birth the mastoid process gradually develops by extending downward, until at five years of age it is very similar to that of an adult, as regards the position of the antrum and arrangement of the cells, except that it is smaller and the bony substance is not as firm and dense. In a pneumatic mastoid process, beside the *antrum* already mentioned, there are usually a number of cells that communicate with one another as well as with the antrum. These contain air, and are lined with a continuation of the mucous membrane of the tympanic cavity, and the epithelium is of the non-ciliated variety. Those cells that are not pneu-

FIG. 16.

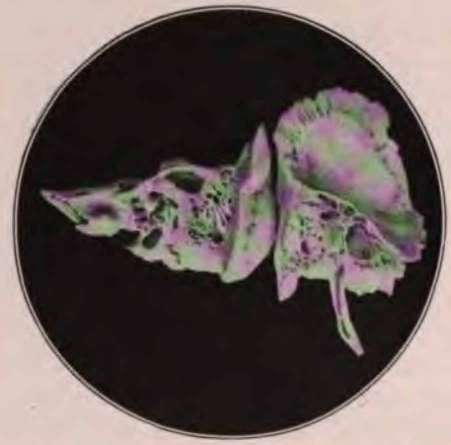


Cortex removed from left temporal bone showing extensive zygomatic cells.

matic usually contain a fatty substance. The upper wall of the antrum is but a thin lamina of bone, which separates it from the dura mater. The lateral sinus is in close proximity to the mastoid cells, and rests against the inner wall of the process. The facial nerve may become involved in inflammation of the mastoid cells, or may be injured during operations, as its course is downward through the cells after passing along the upper portion of the tympanic cavity. A point which serves as an anatomical landmark in operations on the mastoid is the *spina supra meatum.* This is a prominence situated just a little above and behind the external meatus at the junction of the mastoid process with the posterior wall of the external auditory canal. Occasionally there are found cells in the occipital bone that communicate with the mastoid cells. Pus frequently makes its way down to the lowest extremity or tip of the process, and, as the inner wall is very thin, the bone is occasionally perforated, and an abscess may form underneath the muscles and deep fascia in the neck. The lateral sinus occasionally runs out of its usual course, so that great care should always be exercised in operations on the mastoid.

As we have seen that the internal structure of the mastoid process is subject to great variations in different individuals, so the outer surface of the process may have a very thick or a thin wall, or may be rounded or flattened. It is believed very generally that in a normal mastoid process in which the external wall is thick the bone will be found thin at the mastoid tip and digastric fossa; and, further, that when the mastoid protuberance is small and with a well-defined digastric fossa the lateral sinus is apt to encroach upon the mastoid antrum. As the two mastoid processes in an individual are usually symmetrical, valuable information can often be obtained by comparing the normal with the one that is inflamed. In Fig. 17 an infrequent condition is shown, viz., a hollow styloid process communicating with the mastoid cells.

FIG. 17.



Left temporal bone opened, showing hollow styloid process which communicates with the cells of the mastoid.

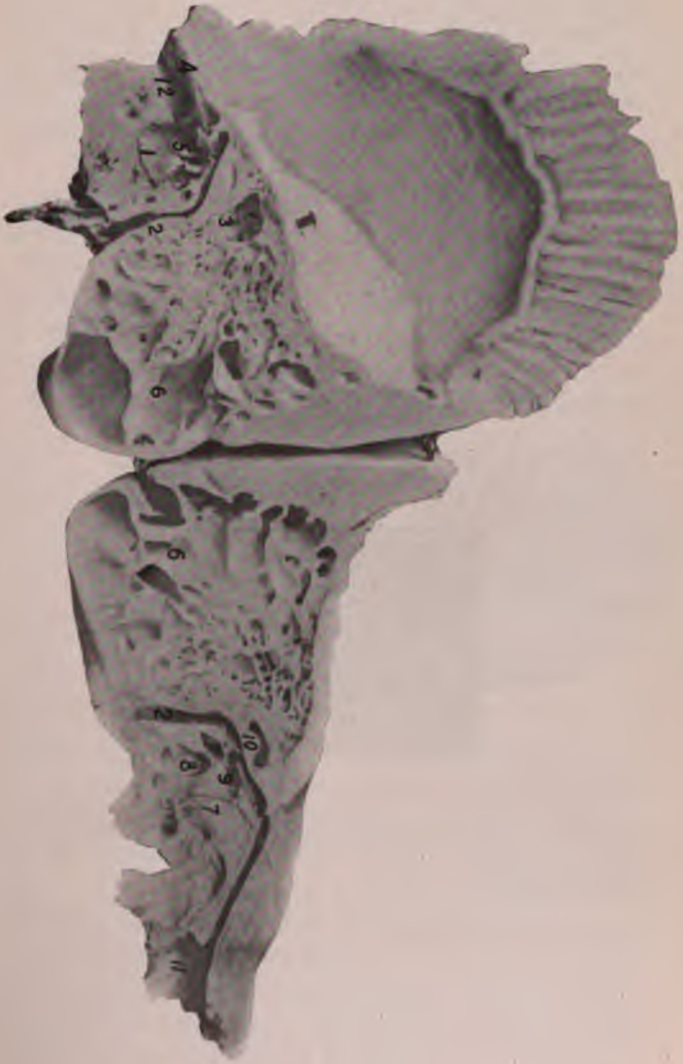
THE INTERNAL EAR.

The inner ear, or sound-perceiving apparatus, consists of a bony and a membranous labyrinth, together with the central origin and trunk of the auditory nerve.

EXPLANATION OF FIG. 18.

Section showing middle ear and mastoid cells, pneumatic variety. 1, membrana tympani; 2, aquæductus Fallopii; 3, mastoid antrum; 4, tensor tympani muscle; 5, malleus and incus; 6, mastoid cells; 7, promontory; 8, foramen rotundum; 9, foot-plate of stapes in foramen ovale; 10, semicircular canal; 11, canal of carotid artery; 12, bony wall of Eustachian tube.

Fig. 18.

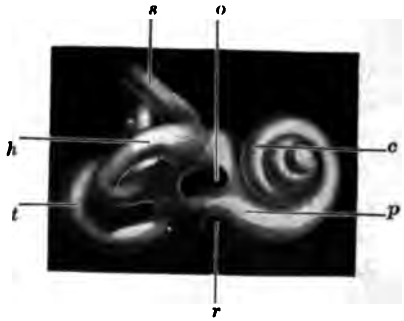


The Labyrinth.

There is a bony labyrinth contained within the petrous portion of the temporal bone, and a membranous labyrinth within the bony one. The *bony labyrinth* is divided into (1) the vestibule, (2) the semicircular canals, and (3) the cochlea.

1. **The Vestibule** lies on the inner side of the tympanum in front of the semicircular canals and behind the cochlea, and is the central cavity by which the different parts of the bony labyrinth are in communication with one another. It is somewhat oval or elliptical in shape. On its outer wall is situated the *fenestra ovalis*, which is closed by the foot-plate of the stapes (Fig. 18), and the latter is held in position by the annular ligament. There is a small depression, called the *fovea hemispherica*, at the anterior part of the inner wall, which contains several minute perforations (macula cribrosa) for the passage of the filaments of the vestib-

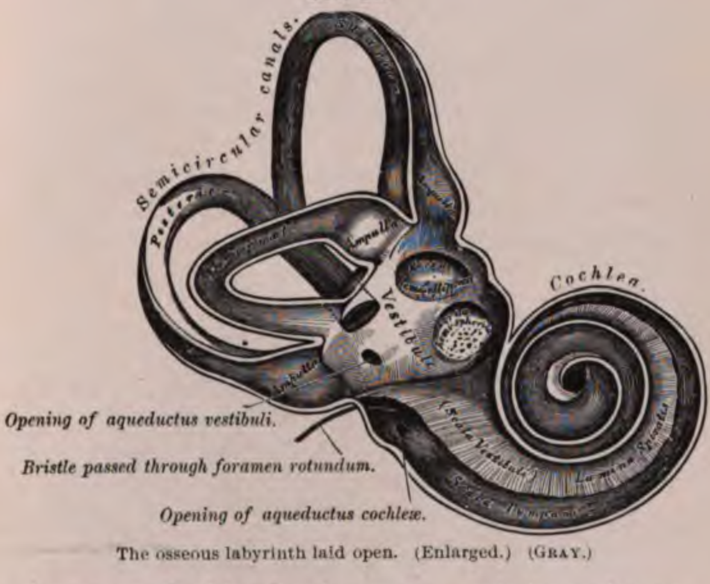
Fig. 19.



Right bony labyrinth (Politzer). *o*, foramen ovale; *r*, foramen rotundum; *p*, promontory; *c*, cochlea; *s*, superior semicircular canal; *t*, posterior semicircular canal; *h*, horizontal or external semicircular canal.

ular nerve. The *crista vestibuli* is a ridge lying behind this depression. At the posterior part of the inner wall is found the opening of the *aqueductus vestibuli* (Fig. 20), through which a small vein passes, and it is claimed by some authorities that it contains a tubular prolongation of the lining membrane of the vestibule, and that it terminates in a cul-de-sac between the layers of the dura mater.

FIG. 20.



The osseous labyrinth laid open. (Enlarged.) (GRAY.)

There is an opening in the vestibule which communicates with the scala vestibuli of the cochlea, called the apertura scalæ vestibuli cochleæ.

2. The Semicircular Canals, three in number, open into the posterior part of the vestibule by five orifices. They are of unequal length, flattened from side to side,

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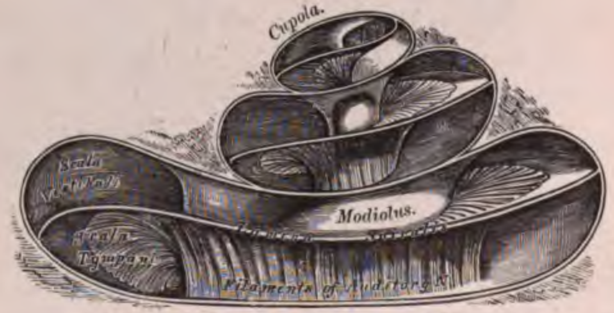
and describe almost a circle in each case. The dilated end of each canal is called the *ampulla*. One of the canals is vertical in direction, and is called (1) *the superior semicircular canal;* another, directed backward, is also vertical in direction, (2) *the posterior semicircular canal;* the third, the shortest of the three, runs in a direction outward and backward, (3) *the external or horizontal semicircular canal.* Each end that is dilated, or has an ampulla, as well as the smaller end of the external semicircular canal, has a separate opening into the vestibule. The smaller ends of the posterior and superior canals, which join before entering the vestibule, have a common opening.

FIG. 21.



The cochlea laid open. (Enlarged.) (GRAY.)

3. The Cochlea. The cochlea, resembling on a cross-section the ordinary garden-snail shell, consists of a tube which takes two and a half turns about its central axis or modiolus (see Figs. 20 and 21). In a macerated

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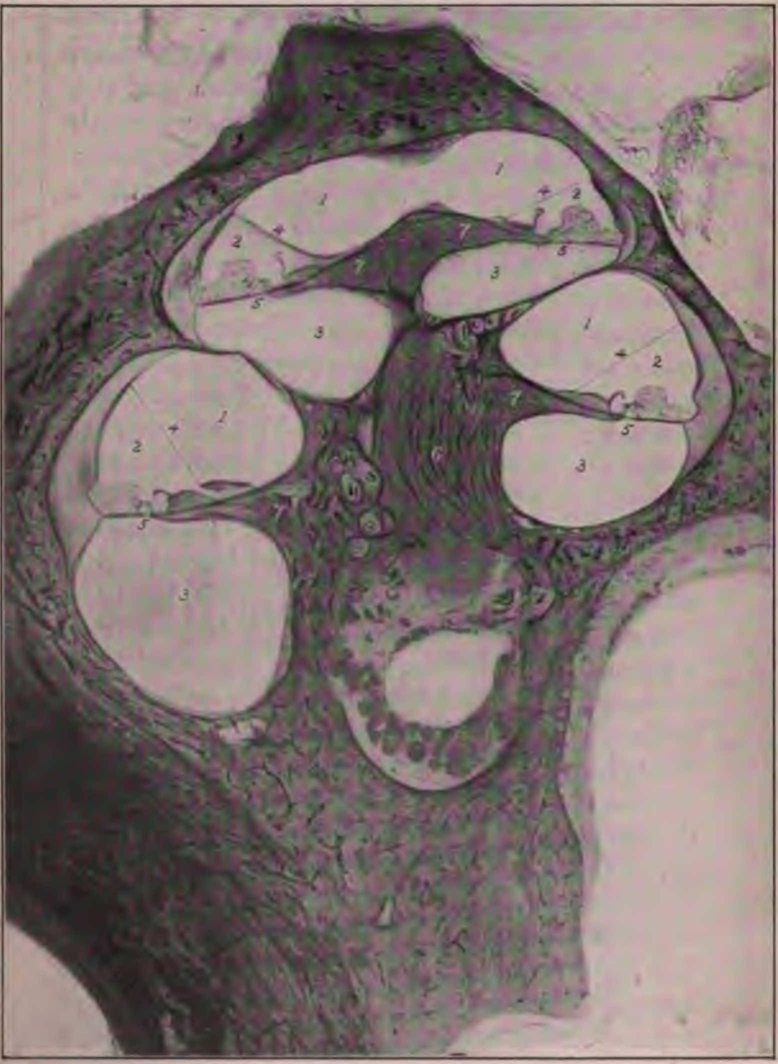
EXPLANATION OF FIG. 22.

After photomicrograph of a section through cochlea of rabbit. Collection of Dr. J. E. Weeks. × 26 diameters. 1, scala vestibuli; 2, scala media; 3, scala tympani; 4, membrane of Reissner; 5, organ of Corti; 6, cochlear nerve lying within the modiolus; 7, ganglion spirale.

FIG. 22.



preparation it will be seen that there is an opening or passage between the cochlea and vestibule, and also a communication between the cochlea and tympanum through the *fenestra rotunda.* The cochlea, conical in shape, is placed almost horizontally in front of the vestibule, with its base directed toward the internal auditory meatus and its apex or cupola toward the tympanic cavity. There are several minute openings in the base for the passage of the cochlear branch of the auditory nerve. The tube or canal of the cochlea is partially subdivided by the *bony lamina spiralis,* which commences at about the fenestra rotunda and ends at the cupola in the *hamulus.* The *membranous lamina spiralis* is inserted into this bony lamina spiralis, so that the canal is thereby subdivided into two passages, the superior called the *scala vestibuli* and the inferior the *scala tympani.* A second membrane cuts off a portion of the scala vestibuli and forms the *scala media* or *ductus cochleæ* (see Fig. 22), but the latter properly belongs to the membranous labyrinth. There is a communication at the apex of the cochlea between the scalæ tympani and vestibuli through the *helicotrema of Breschetius.* There is quite a large canal passing through the centre of the modiolus named the *canalis centralis modioli,* extending from the base to the cupola. It transmits a small nerve and artery. There is an orifice, the *aquæductus cochleæ,* which leads to a canal containing a small vein, and which opens on the basilar surface of the temporal bone. A swelling of the cochlear nerve, called the *ganglion spirale* (see Fig. 22), lies in a small canal, the *canalis spiralis modioli.* This canal winds around the modiolus and lies at a point where the bony lamina is attached to the modiolus.

Ganglion-cells are found in the ganglion spirale, from which nerves pass through the bony lamina to the organ of Corti. The lamina spiralis terminates in a curved extremity, the *sulcus spiralis internus*, the upper lip of which is called the *labium vestibulare*, the lower lip the *labium tympanicum.* Between the labium vestibulare and the origin of the membrane of Reissner is the *crista spiralis.* A delicate membrane, the *membrana basilaris* (see Fig. 23), completing the scala tympani, extends from the labium tympanicum to the *ligamentum spirale*, which appears as an expansion of the membrana basilaris attached to the outer bony wall of the cochlea. The *stria vascularis* is a thin layer of cells resting on that part of the ligamentum spirale between the attachment of the membrane of Reissner and the *prominentia spiralis.* Between the prominentia spiralis and the attachment of the membrana basilaris is the *sulcus spiralis externus*, and this point of attachment of the membrana basilaris is termed the *crista basilaris.* The *membrane of Reissner* is stretched across from the vestibular surface of the periosteum of the bony lamina to the ligamentum spirale, and forms the superior boundary of the scala media, the floor being the membrana basilaris. A very thin membrane, described by Corti and called the *membrane of Corti*, or the *membrana tectoria*, extends across from the attachment of Reissner's membrane and the labium vestibulare to the outer row of hair-cells. The *organ of Corti* consists of numerous rods or cells resting on the membrana basilaris and covered by the membrana tectoria. The two central cells, rod-like in character, are called the *inner* and *outer rods of Corti*, and rest on the membrana basilaris, somewhat separated from one another. This intervening space is called the *zona arcuata* (see Fig. 23). The very small canal thus formed by these arches and by the membrana basilaris, passes in a spiral direction throughout the whole length of the cochlea. Within the zona arcuata will be found two rows of cells, one in each angle formed by the rods of Corti and the membrana basilaris. They are called the *floor cells.* Two nerve-fibres will be observed in Fig. 23, crossing the zona arcuata to the outer hair-cells. The *outer hair-cells* are variously described as from three to five rows in number. They lie to the outer side of the outer rods of Corti, their broad ends directed upward. Between these will be found the cells of Deiter, the broad ends of which are directed downward. There is a single row of *inner hair-cells,* smaller than the outer, lying to the inner side of the inner rods of Corti. They have a layer of supporting cells on the inner side continuous with the epithelium lining the sulcus spiralis internus. Lying in close contact with the upper ends of the rods of Corti and the outer hair-cells will be found a thin reticulated membrane with openings for passage of the

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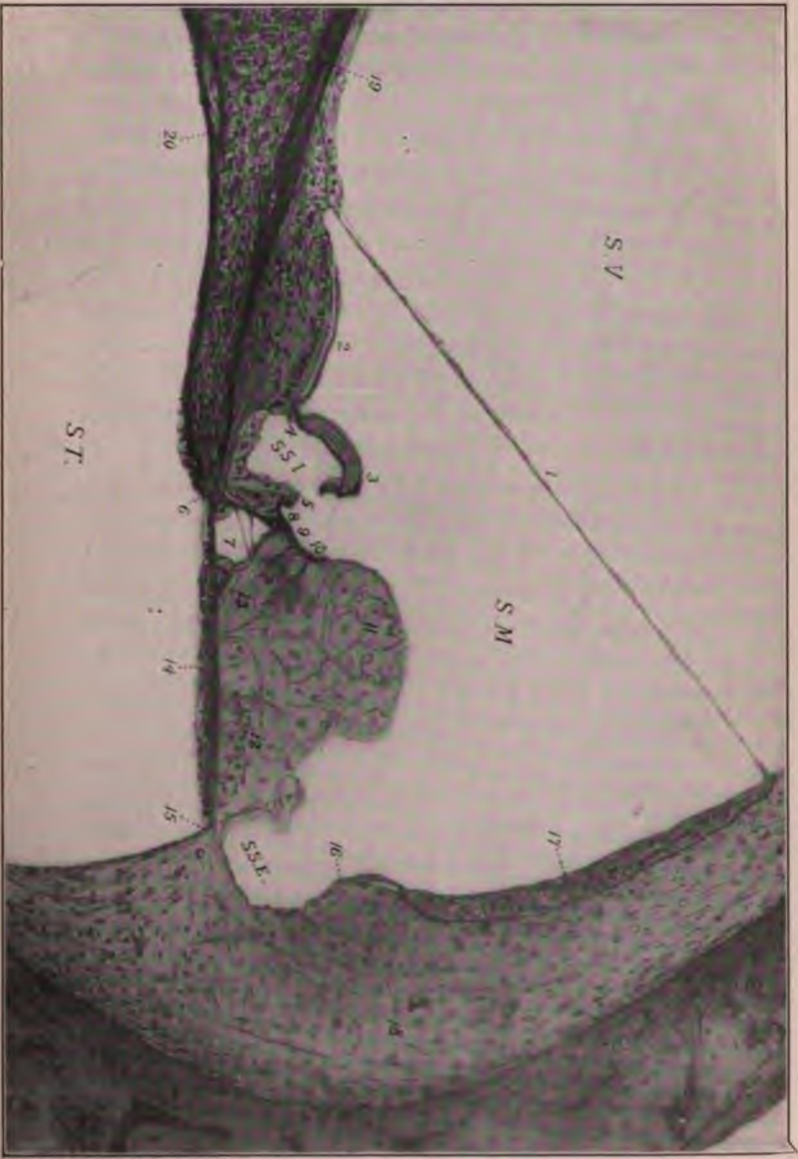
DESCRIPTION OF FIG. 23.

After photomicrograph of a section of the cochlea of a rabbit, showing relations of the organ of Corti. 160 diameters. (Collection of Dr. J. E. Weeks.)

S. V. Scala vestibuli. *S. M.* Scala media. *S. T.* Scala tympani. *S. S. E.* Sulcus spiralis externus. *S. S. I.* Sulcus spiralis internus, with its epithelium.

1. Membrane of Reissner. *2.* Crista spiralis. *3.* Membrana tectoria, or membrane of Corti. *4.* Labium vestibulare. *5.* Inner hair-cells. *6.* Labium tympanicum. *7.* Zona arcuata, showing its floor-cells and two nerve-fibres passing to outer hair cells. *8.* Inner rod of Corti. *9.* Outer rod of Corti. *10.* Lamina reticularis or membrane of Kölliker, covering the outer hair-cells. *11.* Supporting cells of Hensen. *12.* Cells of Claudius. *13.* Deiter's cells. *14.* Membrana basilaris. *15.* Crista basilaris. *16.* Prominentia spiralis. *17.* Stria vascularis. *18.* Ligamentum spirale. *19.* Upper plate of bony lamina spiralis. *20.* Lower plate of bony lamina spiralis.

FIG. 23.



cilia of the outer cells. It is known as the *lamina reticularis*, or membrane of Kolliker, and seems to serve the purpose of binding together the cells over which it lies.

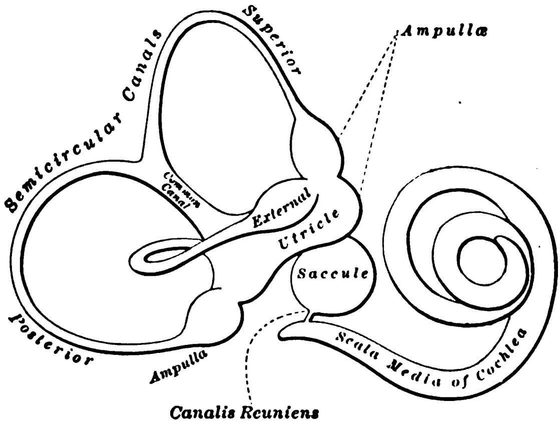
A mass of cells are present on the outer side of the organ of Corti which appear to be for the support of that organ. There are more of them, and they extend higher into the scala media in the rabbit (from which Fig. 23 is taken) than in the human subject. The cells forming the upper portion are known as the supporting cells of Hensen, those forming the lower outer portion, with the large number of small nuclei, resting on the basilar membrane and extending outward to the crista basilaris, are called the cells of Claudius.

The *membranous labyrinth* consists of (1) the membranous canals, (2) the utricle, and (3) the saccule and is encased in hard, ivory-like bone known as the labyrinthine capsule. The *membranous semicircular canals* are similar in number, arrangement, and general form to the bony canals, except that they are only about one-third the size of the latter. They open by five orifices into the utricle, one opening being common to two canals. The ampulla is much thicker than the other portions of the canal, and almost fills the bony encasement. The membranous canal consists of three layers, the inner being formed of polygonal nucleated epithelial cells which secrete the *endolymph*, a fluid which is contained within the membranous tubes. A fluid quite similar to the endolymph, called the *perilymph*, surrounds the membranous canals and is contained within the osseous canals. The ampullæ receive nerve-filaments from the vestibular nerve.

The *utricle*, oblong in shape, lies in contact with the fovea hemielliptica in the superior and posterior part of the vestibule. There is a yellow thickening on the anterior and lateral walls of the utricle, called the *macula acustica*. A clear, transparent semifluid substance covers the neuro-epithelium of the macula acustica, and contains crystals of carbonate of lime called the *otoliths*.

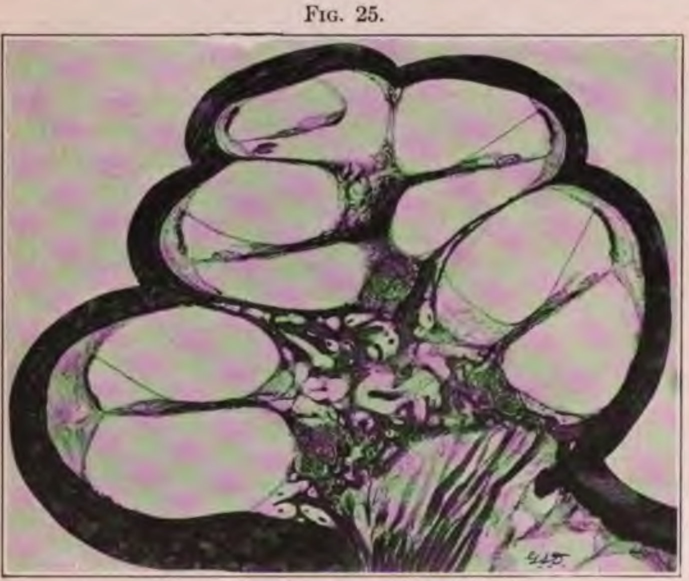
The *saccule*, globular in shape, is situated in the fovea hemispherica, and apparently its cavity is distinct from that of the utricle. It has a macula acustica, and otoliths similar to those in the utricle. There is a small canal, the *canalis reuniens* (see Fig. 24), connecting the saccule with the ductus cochlearis of the membranous labyrinth. A number of stiff cilia project from the surface of the macula in both saccule and utricle, and are connected with the nerve-filaments of the auditory nerve.

Fig. 24.



The arteries supplying the labyrinth are: the (1) internal auditory, which is a branch of the basilar; (2) some branches from the occipital; (3) the stylomastoid, from the posterior auricular. The *internal auditory artery* subdivides at the bottom of the internal auditory meatus into the *cochlear* and *vestibular* branches. The cochlear branch gives off numerous small vessels which pass through the canals in the modiolus and enter the substance of the lamina spiralis in the form of a capillary network. The vestibular branch forms a capillary network which is distributed to the membranous labyrinth.

FIG. 25.

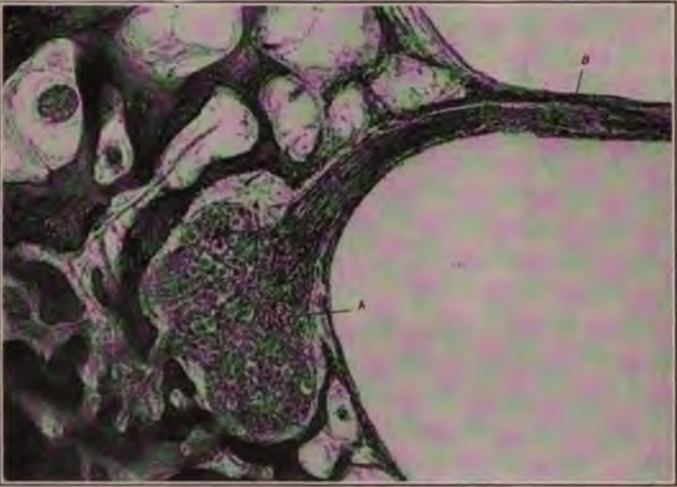


Section through human cochlea. (Dixon.)

The veins from the semicircular canals, the vestibule, and the cochlea unite with the superior petrosal sinus.

The *auditory nerve*, or nerve of hearing, also called the portio mollis, is the eighth nerve. Its superficial origin is at the lower border of the pons from a groove between the olivary and restiform bodies. There are two deep origins, both from the fourth ventricle. The nerve, after winding around the restiform body, passes, together with the facial nerve, across the posterior border of the middle peduncle of the cerebellum and enters the internal auditory meatus with the facial nerve. At the bottom of the meatus the nerve divides into the *cochlear* and *vestibular* branches.

Fig. 26.



Section through a portion of modiolus and lamina spiralis, showing (*A*) ganglion spirale, and (*B*) nerve fibres passing outward to be distributed to the organ of Corti. (Dixon.)

The vestibular branch subdivides into the superior, middle, and inferior branches, which are distributed to the cristæ acusticæ of the semicircular canals and the maculæ acusticæ of the utricle and saccule. The cochlear branch divides into numerous twigs, and, after entering the base of the modiolus, forms a plexus, the "ganglion spirale" near the base of the lamina spiralis. From this plexus nerve filaments pass between the plates of the osseous lamina spiralis and are distributed to the sulcus spiralis and organ of Corti.

PHYSIOLOGY.

The function of the auricle is to collect the sound-waves and direct them to the membrana tympani. The concha is especially important for this purpose, as well as the cavity just beneath the tragus. After the sound-waves have reached the drumhead through the external auditory canal, they are transmitted by the chain of ossicles to the fluid of the labyrinth, the ossicles probably vibrating as whole bodies. The sound-waves then pass through the fluid in the cochlea and reach the organ of Corti. From the nerve-filaments in the cochlea the sensations called sound are conveyed through the auditory nerve to the brain centre. The cochlea, being the organ to receive the waves of sound, is sometimes called the *acoustic labyrinth*, while *static labyrinth* is the name often applied to the semicircular canals and the vestibule which have to do with the maintenance of equilibrium.

According to experiments made by Helmholz, it seems that the power of resonance of curved membranes is much greater than that of flatly stretched ones, a point of great importance in considering the concavity of the drumhead. Experiments have also shown that the vibrations of the malleus are twice as great as those of the incus and four times as great as those of the stapes. It is probable that by means of the cochlea the pitch of the sound is appreciated, and, further, that different notes are perceived by certain portions of the spiral scale. As to the function of the fenestra rotunda, it is probable that, owing to its elasticity, when the footplate of the stapes is forced in and the labyrinthine pressure is increased, such pressure is compensated for by the bulging outward of this membrane. When this delicate membrane becomes thickened through pathological changes, the patient is likely to complain of noises in the ear and vertigo, if the pressure within the labyrinth is suddenly increased.

It was formerly believed that the function of the semicircular canals had to do with the perception of the general direction of sounds, but it is more probable, and a fact generally accepted, that the sense of motion and of equilibrium is the function of the semicircular canals and the utricle.

By means of the Eustachian tube, air enters the middle ear and thus keeps the atmospheric conditions equalized on both sides of the membrana tympani. It also acts as a drain for the middle ear or tympanum. The Eustachian tube is not constantly open, as its permeability varies in different individuals. In some persons a current of air will pass from the pharynx to the middle ear during ordinary respiration, while in others the act of swallowing or a powerful expiratory act, with nostrils open or closed, will be necessary to cause the air to enter the Eustachian tube. When constriction of the tube takes place, so that the air does not enter the tympanum except with difficulty, the result is that the drumhead and ossicles are forced inward, and congestion of the middle ear occurs, which condition, if not relieved, is likely to be followed by deafness.

CHAPTER II.

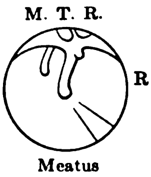
METHODS OF EXAMINATION OF THE EAR.

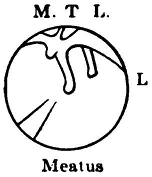
When a patient presents himself for advice and treatment for some aural disease, a complete history of the case should first be obtained. He should be questioned as to whether he has any hereditary tendency to deafness; then inquiry should be made as to his general health, particularly as to any predisposition to catarrhal disease. The patient should then be questioned as to the exact symptoms for which he comes for advice, and the surgeon should make careful note of the pain, if present, the tinnitus, the discharge, or vertigo. A chart, such as the following, is excellent for recording histories.

NEW YORK EYE AND EAR INFIRMARY.
Otological Examination.

PHYSICAL EXAMINATION

Tube	R.	
	L.	
Mastoid	R.	
	L.	





FUNCTIONAL EXAMINATION

Watch or Acoumeter	R	Before After
	L	Before After
Whisper or Speech	R	Before After
	L	Before After
	R	Before After
	L	Before After

Tone Limits	R	Upper	Before After
		Lower	Before After
	L	Upper	Before After
		Lower	Before After
		Bc. Ac. R	Before After
		Bc. Ac. L	Before After

Bc.
(Fork)

Spontaneous Nystagmus
- Rt.
- Lt.

Nystagmus
Sec.

Turning
- Erect Posture
  - Rot. to Rt.
    - Horizontal
    - Rotatory
  - Rot. to Lt.
    - Horizontal
    - Rotatory
- Head Forward
  - Rot. to Rt.
    - Horizontal
    - Rotatory
  - Rot. to Lt.
    - Horizontal
    - Rotatory

Causation
- R
  - 1
  - 2
- L
  - 1
  - 2

Nystagmus

Caloric
- Heat
  - Rt.
    - Present
    - Absent
  - Lt.
    - Present
    - Absent
- Cold
  - Rt.
    - Present
    - Absent
  - Lt.
    - Present
    - Absent

Ataxia
- Jumping forward with eyes closed, falls
  - Backward
  - Forward
  - Right
  - Left
- Jumping backward with eyes closed, falls
  - Backward
  - Forward
  - Right
  - Left
- Standing with eyes closed, falls
  - Backward
  - Forward
  - Right
  - Left

AURAL HISTORY

Duration—R
- Impaired Hearing
- Tinnitus
- Discharge
- Pain
- Vertigo

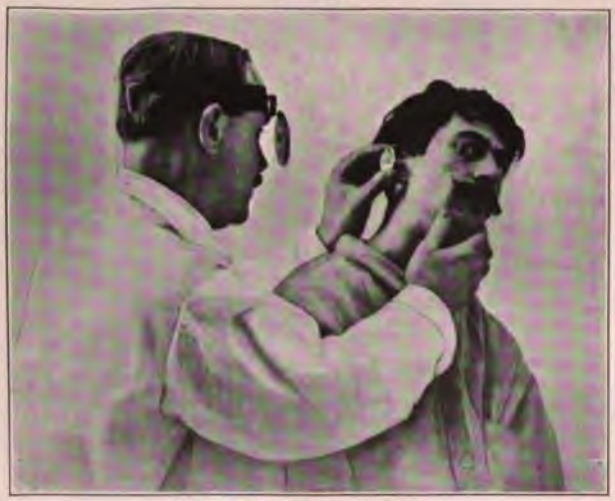
Duration—L
- Impaired Hearing
- Tinnitus
- Discharge
- Pain
- Vertigo

Diatheses

Heredity

After having obtained (1) a full and complete history of the case in all its details, the surgeon should then (2) inspect with the eye the auricle and surrounding parts, looking for any inflammation of the pinna or external meatus, or any redness over the mastoid process. By palpation some information can be obtained, especially if there is any tenderness on pressure over the mastoid process. It is always well to compare both auricles and both mastoid processes of a patient, for it must be remembered that in some persons, generally those of an hysterical temperament, pain is occasionally complained of when firm pressure is made over the apex of the mastoid, so that it is always well to compare the two sides. Redness and tenderness over the mastoid are symptoms suggestive of mastoid inflammation or

FIG. 27.

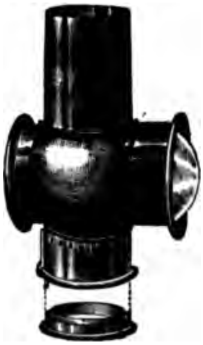


Indirect illumination of the ear.

furuncular inflammation of the *external meatus.* After having obtained all information possible by inspection and palpation, the surgeon should then (3) make a most thorough examination, by means of the head-mirror and speculum, of the external auditory canal, the membrana tympani, and, if the latter is perforated, of the tympanic cavity.

A very good head-mirror is the one recommended by Politzer. It is a concave mirror, with an aperture in the middle which allows the surgeon to look through the opening, if he desires to do so, and it should be fastened to the forehead-band or metal spring by means of a ball-and-socket joint. The mirror is two and three-quarters inches in diameter and has a focal distance of about six inches. In order to obtain the best view of the drumhead, the mirror should be pulled down over the eye, so that the surgeon can look through the opening; and to make a thorough examination of the external meatus and membrana tympani, it is most

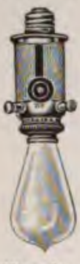
FIG. 28.



Mackenzie's bull's-eye lens and reflector.

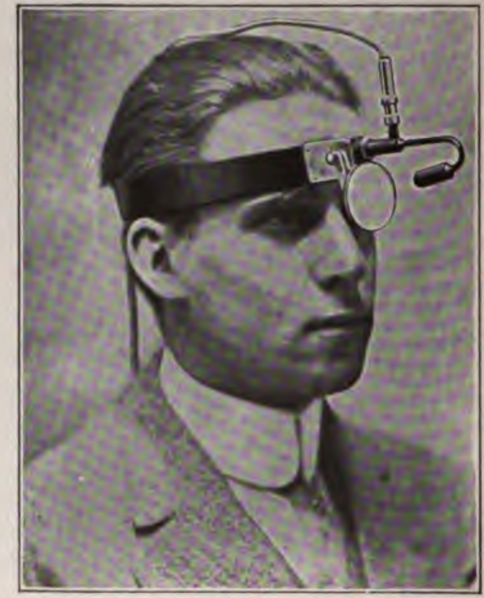
important to have good illumination, and for this purpose daylight from a northern exposure is the most satisfactory, since by this means the natural color of the drumhead will be preserved. Direct sunlight is usually too dazzling.

FIG. 29.



Wappler controller.

FIG. 30.



The Schoonmaker acmi head-light.

A convenient mirror for students and general practitioners, which can be used for both ear and throat cases, is one having a diameter of three inches and a focal distance of about twelve inches.

When good natural light cannot be obtained, artificial light should be substituted, such as that from an electric bulb or an Argand burner, with or without a Mackenzie bull's-eye lens and reflector.

A fairly satisfactory light is that obtained from a candle fitted in a holder and supplied with a lens. This can be carried by the surgeon in his satchel, and is particularly adapted for bedside examinations.

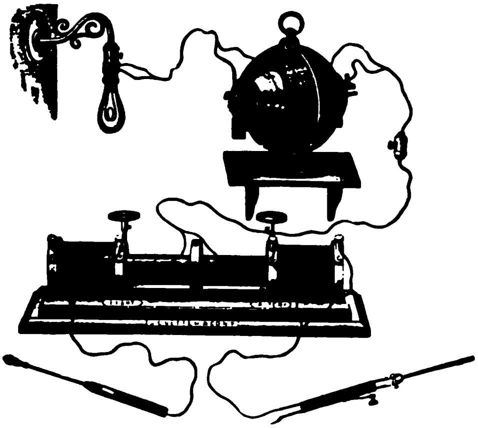
Illumination of the ear may be obtained by indirect illumination, as when an electric bulb or Argand burner or natural daylight is used, or by direct illumination, the latter method consisting of an electric lamp attached to the head-band.

An excellent electric heal-light is made by the Wappler Electric Controller Company, of New York, and shown in Figs. 29 and 30. The rays of a small electric lamp are concentrated by a comparatively small condensing lens. A hollow mirror, fitting between the eyes, totally reflects the rays at the highest point of concentration, and in this way a disc of even light is obtained at from ten to eighteen inches from the mirror. This light can be used with a pocket battery containing a rheostat, or the street current can be utilized by means of the Wappler controller (Fig. 29).

A varied range of current may be had with this controller. If a 16 C. P. lamp is inserted in the socket, one-third ampere and from 0 to 25 volts can be obtained from the binding post; with a 32 C. P. lamp, eight-tenths ampere and about 40 volts can be had. A rack and pinion movement makes it possible to increase the voltage by steps of one-third of a volt.

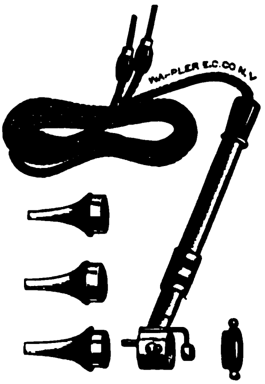
In order to make use of the electric current in a city house, a rheostat has been devised, which regulates the current so that the surgeon is enabled not only to obtain a good illumination of the ear, but also to make use of a cautery or bone-drills (Fig. 31). For operations on

FIG. 31.



Electric motor with rheostat.

FIG 32.

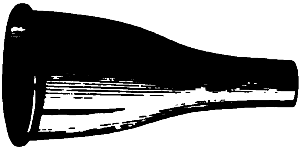

WA-PLER E.C.CO N.Y.

Wappler auroscope.

the middle ear, and for examinations and operations performed at night, on account of the danger of conflagration, the electric light is indispensable, and should be used whenever possible. The only objection to the photophore for general use is that it becomes very hot when employed for any length of time, and consequently very disagreeable to the surgeon.

The Wappler auroscope (Fig. 32) is fitted with a lens which focuses the light so that a magnified view of the membrana tympani is shown. The large lens is removable, and a small magnifying lens can be placed in position, and thus leave the opening of the speculum free for the introduction of instruments. By attaching the Siegle otoscope at a point on the side of the speculum the mobility of the drumhead can be observed provided the different parts of the instrument fit accurately.

FIG. 33.

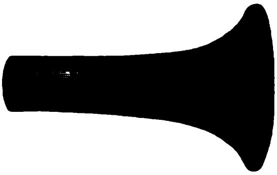


Gruber's speculum.

When making an examination with a head-mirror, it is of the greatest importance to place the patient in a good position (Fig. 27). The ear to be examined should be away from the light. If gaslight is used, the Argand burner should be on a level with the ear, and the rays of light, striking the head-mirror at an angle of 45 degrees, should be reflected into the external auditory canal.

Speculum. The speculum that I find most satisfactory is that known as Gruber's. It is constructed of silver, the narrow part being highly polished inside, while the dilated portion inside is blackened. There

FIG. 34.

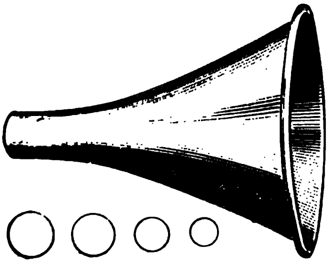


Politzer's speculum.

are four sizes of these specula. The end to be introduced is conical in shape (Fig. 33), which allows the speculum to fit more accurately the external meatus, so that the surgeon is enabled to obtain a better view of both the external auditory canal and the drumhead.

Politzer's specula (Fig. 34) of hard rubber are also excellent ones, and will be found especially useful when caustic applications are to be made to the canal or drumhead. The Gruber speculum is also made of hard rubber. Another speculum is that devised by Boucheron,

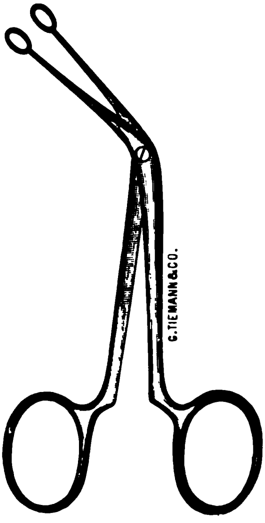
FIG. 35.



Boucheron's speculum.

of Paris (Fig. 35). I have modified the latter by having the extremity of the narrow end made oval instead of round. Before introducing the speculum it should be warmed, and particular care exercised that it is not pushed in too far, as pressure on the bony canal is quite painful. After the speculum has been warmed, it should

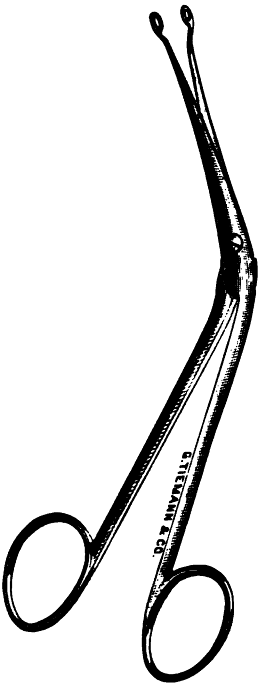
FIG. 36.



Author's curette forceps.

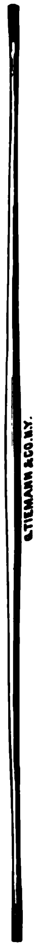
be held by the thumb and index finger of the left hand, and with a gentle rotary motion carefully introduced into the meatus, while the auricle, held between the index finger and middle finger of the same hand, should be drawn outward, upward, and backward. Occasionally, long hairs obstruct the view. These should be pushed aside, while any cerumen, scales, purulent or cheesy matter should be removed by syringing or by means of curettes or forceps, as the case may be. Mistakes are frequently made by beginners in not pushing

Fig. 37.



Foreign-body forceps.

Fig. 38.

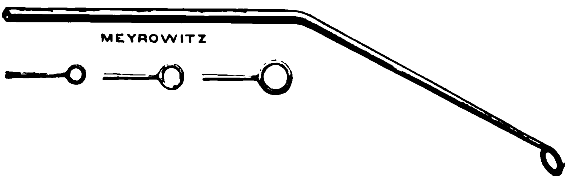


Aluminium cotton-applicator.

the speculum beyond the hairs at the meatus, which at times are covered with cerumen, so that a diagnosis of inspissated cerumen is occasionally made. Again if the long axis of the speculum is not directed toward the drumhead, but against the walls of the auditory canal, the student will make a mistake in diagnosis, as the walls are frequently smooth, glistening and pinkish in color, resembling at times an inflamed drumhead.

Operating Ear Specula. For operative purposes specula have been devised with a slit-like opening in the narrow part of the speculum, to allow greater play for the use of instruments. A short speculum is especially adapted for such purposes. Blake's operating otoscope "consists of a hard-rubber speculum (Politzer), fitted with a metallic rim, to which are attached a revolving prism and an arm bearing at its outer end a lens of about an inch focus; this arm is movable, but sufficiently firm to remain fixed at any angle at which it is placed."

FIG. 39.



Blunt curettes.

All drops or solutions used in the ear should be warmed first, for otherwise they are liable to cause vertigo and inflammation. The syringe is the safest instrument that can be placed in the hands of the beginner, for the purpose of removing cerumen, purulent discharge, or scales, while forceps and curettes should never be used by the inexperienced, nor at any time, except under excellent illumination. The curette forceps (Fig. 36) I have used for many years, and find them especially adapted to removing hardened cerumen when syringing alone has failed. Another pair of forceps that will be found of service are those represented in Fig. 37.

In addition to the forceps, it is necessary that the surgeon should be well supplied with cotton-carriers (Fig. 38). Those of aluminium will be found the most serviceable, on account of their lightness and flexibility. The surgeon will find it necessary to have several sizes of blunt curettes, for the purpose of removing scales, cerumen, etc., from the auditory canal.

APPEARANCES OF THE NORMAL EXTERNAL AUDITORY CANAL AND MEMBRANA TYMPANI.

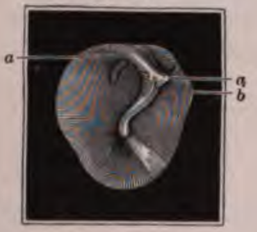
After introducing the speculum and pushing aside any hairs in the meatus, one should observe the appearance of the auditory canal. The osseous part of the normal canal is usually of a delicate pink color and somewhat smooth and glistening. A reflex cough is frequently caused by introducing the speculum, due to irritation of the auricular branch of the pneumogastric.

The normal membrana tympani, when examined by daylight, is of a pearly-gray color with a slightly bluish tint, while gaslight gives it a reddish-yellow color. Other points to be observed are the long handle of the malleus, running downward and backward from the short process to the umbo or central concavity of the membrana. The cone or pyramid of light, as shown in Figs. 40 and 41, extends from the umbo almost to the lower periphery of the drumhead, with the apex at the anterior part of the umbo. It is supposed to be due partly to the concavity of the drumhead and to the angle that the membrana tympani forms with the axis of the canal, and partly to the glistening or reflecting surface of the membrana.

From the short process, extending forward and backward, are two folds called the *anterior* and *posterior folds*. The portion of the drumhead between these folds above the short process is called the *membrana flaccida*, the portion below being the *membrana vibrans*.

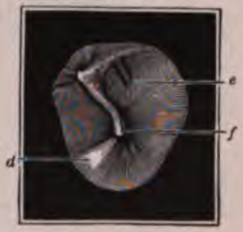
In looking at a drumhead, one must note particularly (1) its color, whether normal, congested, opaque, or atrophic, and whether it contains opacities or chalky deposits; (2) the position of the drumhead, whether bulging, owing to a collection of fluid, or whether retracted. In the latter case the handle of the malleus, being retracted, will appear foreshortened; the short process will become more prominent, as well as the anterior and posterior folds, and the cone of light will

FIG. 40.



Normal drumhead (right ear).

FIG. 41.



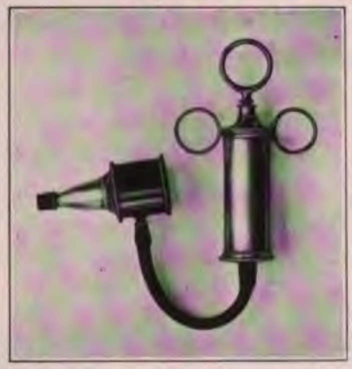
Normal drumhead (left ear).

(POLITZER.)

a. Posterior fold. *b*. Short process. *c*. Anterior fold. *d*. Cone of light. *e*. Long handle of incus. *f*. Umbo.

be distorted or displaced. To decide as to the mobility of the drumhead, and whether bound down by adhesions, in addition to the Valsalvian method of inflation (to be described later), more or less can be determined by touching the different parts with a probe. For this purpose, however, an instrument has been devised—viz., Siegle's pneumatic speculum or otoscope—consisting of a hard-rubber cylinder closed at one end by an obliquely placed thin plate of glass. There is a small opening on the side, connected by rubber tubing with a Politzer bag, or, better still, with the author's masseur (Fig. 42). At the other extremity of the cylinder a speculum is attached, and it is well to cover the narrow end of the speculum with a small piece of rubber tubing, to make it fit the canal accurately and thus render the instrument air-tight. By manipulating the piston with the thumb the mobility of the membrane can be determined. I have modified this instrument by substituting the Gruber metallic speculum for the

FIG. 42.



Siegle's otoscope, with author's masseur attached.

hard-rubber ones, which are, as a rule, attached to this instrument (Fig. 42).

The use of the Siegle otoscope, for the purpose of exhausting the air in the external auditory canal, is indicated in cases of retraction of the drumhead due to catarrhal disease; to break up adhesions between the drumhead and walls of the middle ear; in certain cases of tinnitus, which frequently are much benefited after its use, and in cases of dizziness due to increased labyrinthine pressure from middle-ear disease; also in certain cases of perforation of the drumhead in which it is important to remove the secretion. The author's masseur is particularly useful in cases of adhesion between the membrana and walls of the tympanum, as rarefying and condensing the air in the external meatus effect what Delstanche calls "massage of the articulation of the ossicles." All instruments for either rarefying or condensing the air in this manner should be used with great caution, and only when the surgeon can obtain a good view of the drumhead during manipulation.

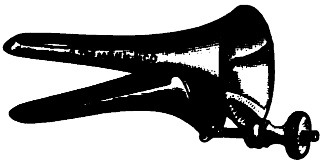
APPEARANCE OF THE PHARYNX, NASOPHARYNX, AND NASAL PASSAGES.

The surgeon should not consider the examination of the ear complete until he has inspected carefully the pharynx, the nasopharynx, and the nasal passages. For this purpose, in order to direct the light, a larger head-mirror is advisable.

First of all, the tongue should be depressed by means of a spatula and the patient directed to make an inspiratory effort or to pronounce the word "ah," which latter procedure will raise the soft palate, and present an excellent view of the pharynx. Careful attention should be paid as to whether the pharynx is atrophic, hypertrophic, or granular, whether the tonsils are enlarged or not, and whether there are any ulcers.

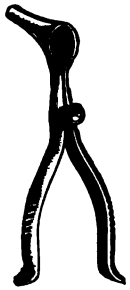
As to the nasal passages, one should direct the patient to close one side of the nose and to force air in and out of the other passage, and to do the same on the other side, in order to determine the permeability of these passages. Afterward, inspection by means of a nasal speculum (Figs. 43 and 44) should be made, to ascertain the presence of polypi, spurs or deviations of the septum, or to detect malformations, disease of the bone, or hypertrophic or atrophic nasal catarrh, or ozæna.

Fig. 43.



Colin's nasal speculum.

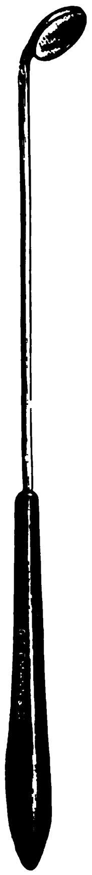
Fig. 44.



Bivalve nasal speculum.

After the pharynx and the nasal passages have been explored, the attention of the surgeon should be directed to the condition of the nasopharynx. A mirror (Fig. 45) should be warmed and carefully passed behind the soft palate, and the nasopharynx should be so illuminated by means of the head-mirror that the surgeon can decide if there are adenoid growths present, or polypi or hypertrophy of the mucous membrane, or any other abnormal change in the tissues. In children it is particularly difficult to employ posterior rhinoscopy, and in such the index finger may be easily passed up behind the soft palate, and the presence or absence of adenoid growths may be ascertained. In nervous and excitable children this method should be employed with caution, as I have seen little patients rendered so nervous by it that it was extremely difficult for the aural surgeon to regain their confidence. Whenever possible, it is much more satisfactory and considerate to give the patient a few inhalations of chloroform.

FIG. 45.



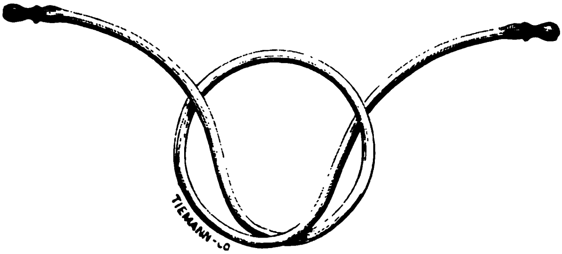
Mirror for posterior rhinoscopy.

EXAMINATION OF THE EUSTACHIAN TUBE AND MIDDLE EAR.

In order to ascertain the condition of the Eustachian tube, it is necessary to try one of three methods of inflation, viz., (*a*) Valsalvian method, (*b*) Politzerization, (*c*) Catheterization. A diagnostic tube (Fig. 46), consisting of rubber, from two and one-half to three feet in length, and provided with ivory tips, should always be used. One end is placed in the surgeon's ear and the other in that of the patient (Fig. 47). When inflating the ear by either of the three methods, certain information can be obtained as to the condition of the Eustachian tube. In a normal case, when the middle ear is inflated a dull sound or click will be heard. The presence of fluid in the tympanic cavity will give rise to a bubbling sound, while a perforation in the membrana tympani will be indicated by a blowing or hissing sound, according to the size of the perforation and the condition of the tube.

(*a*) Valsalvian Method. By this method the patient holds the nose closed with the thumb and index finger, and, the mouth also being closed, the condensed air in the nasopharynx is forced through the Eustachian tube into the tympanum when the patient makes a forced expiration. This method is useful only in cases in which it is desirable to make a diagnosis of the permeability of the Eustachian tube and to determine the mobility of the membrana. The drumhead should be inspected under good illumination whenever this method is employed; but the latter should never be recommended to patients, as it tends to produce congestion of the head, and when frequently practised, and

Fig. 46.

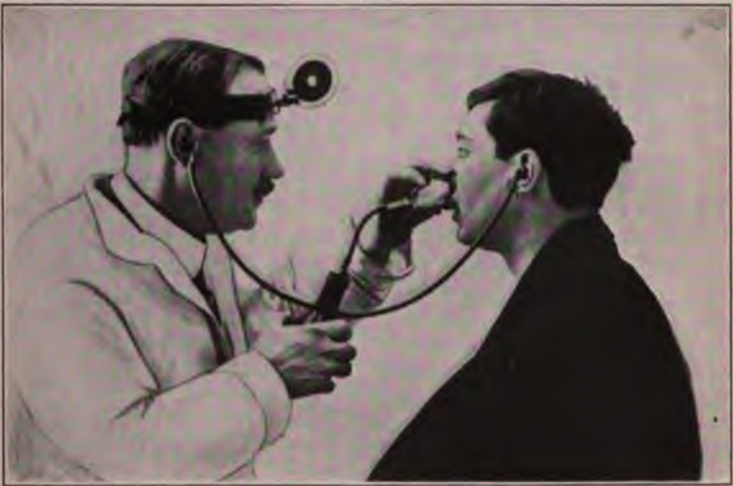


Diagnostic tube.

for a long period of time, it is likely to stretch the ligaments of the ossicles, and thus cause a relaxed condition of the parts. This method is of limited value, and should never be used where there is much obstruction to the entrance of air in the tube.

(*b*) Politzer's Method. The method of Politzer is described best in his own words, as follows: "The patient, being seated in a chair, takes a little water into his mouth—to facilitate swallowing—which he is required to swallow when told. The surgeon, standing on the patient's right, or in front, introduces the glass inhaler attached to the Politzer bag into the nasal orifice of the corresponding side (Fig. 47), and then compresses with the left thumb and forefinger the alæ of the nose closely round the instrument. The

Fig. 47.



Politzer's method.

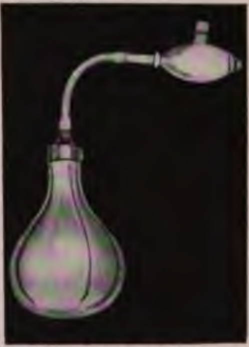
patient is next told to perform the act of swallowing, and at the same moment the surgeon expels the air from the inflating-bag with his right hand. By the condensation of air produced in the nasopharynx in this manner the air is forced into both middle ears, the closure effected by the soft palate is forced open, and its vibrations give rise to a dull, gurgling noise, which frequently, if not always, may be taken as an indication that the air has entered into the middle ear." Politzer has partially modified this method by allowing the patient to inspire through the nearly closed lips, or through a piece of rubber tubing held between the lips while the air is being forced into the nasopharynx. By this modification of the original method the nasopharynx is not only closed, but at the same time the Eustachian tube is made more open by the soft palate being pulled backward. By inspiration through the mouth air enters the middle ear more readily when the catheter is used than by simple catheterization.

In inflating the middle ear, in cases where there is fluid, it is well to have the patient's head inclined forward and sideways, in order to allow the secretion to gravitate toward the nasopharynx.

In cases of perforative inflammation of the middle ear it seems to be proved that, by Politzer inflation, the secretion in the middle ear is forced through the opening in the drumhead and not into the mastoid cells. In cases of hyperæmia of the middle ear, with deafness resulting from inflammatory action, inflation of the middle ear in many cases will produce absorption of the exudation, and will also have a favorable effect on the circulation in the tympanic cavity.

The fact that a hissing sound is not always heard when the Valsalvian or Politzer method has been tried does not indicate that there is not a perforation of the drumhead, for there may be so much swelling or constriction of the tube that catheterization will be necessary to force air through the perforation.

FIG. 48.



Politzer's bag, with glass inhaler attached.

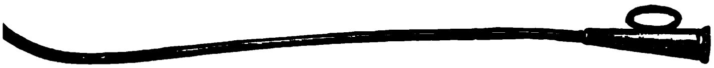
The Politzer bag (Fig. 48) is pyriform in shape, and should hold about eight ounces. A rubber tube, six inches in length, should be attached to the bag, and the nosepiece should be of glass, large enough to completely fill the nasal orifice, glass being easily cleansed and rendered aseptic.

It is best to have a small opening on the side of the bag, which should be covered over by the thumb when compressed. The thumb should be removed immediately from the opening after compressing the bag, so as to allow the air to enter the bag through this opening. Otherwise the air and possibly some secretion may be drawn through the glass attachment.

Instead of having the patient swallow water, another method, recommended by Gruber, consists in the pronunciation of the word "hock" by the patient at the moment that the surgeon forces air through the nose. Still another way is to have the patient blow with the mouth closed and thus swell out his cheeks without letting the air escape. With young children both of these methods are unnecessary, for if the mouth of the child is closed, it simply is necessary to use the Politzer bag. If the child cries, it will facilitate matters.

(c) CATHETERIZATION. Both hard-rubber and silver catheters are used. I prefer, however, the latter (Fig. 49), of which there are four different sizes; it is most important that each should have a probe-pointed extremity for introduction into the nose. The catheter should have a double curve, as recommended by Blake. The catheters formerly in use caused considerable pain and irritation when introduced. By using a catheter with a probe point very little discomfort is caused to the patient if the surgeon is skilful, and there is little if any danger of lacerating the parts and thereby causing emphysema of the connective tissue of the pharynx and neighboring parts.

FIG. 49.

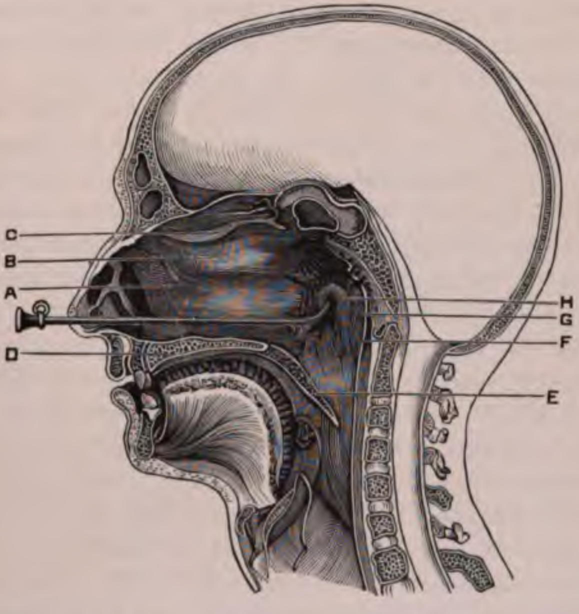


Blake's Eustachian catheter.

The use of a 4 per cent. solution of cocaine sprayed into the nasal passages is advisable in some cases before passing the catheter, provided the patient is not unpleasantly affected by this drug. The surgeon, however, should never resort to cocaine if he can possibly do without it, for fear the patient may ultimately contract the cocaine habit, and if he does use it, he should keep the patient ignorant of the fact. The author has besides seen patients whose general health was seriously impaired by this practice on the part of the otologist, viz., of always spraying the nasal passages with a cocaine solution before introducing the catheter. There are two methods generally employed in introducing a catheter.

First Method. The patient should be seated opposite

FIG. 50.



Vertical section of the nasopharynx, with the catheter introduced into the Eustachian tube. (POLITZER.)

A. Inferior turbinated bone. B. Middle turbinated bone. C. Superior turbinated bone. D. Hard palate. E. Velum palati. F. Posterior pharyngeal wall. G. Rosenmüller's fossa. H. Posterior lip of the orifice of the Eustachian tube.

the surgeon, and the former's head steadied by an assistant or allowed to rest against the back of a chair. The surgeon, either standing or sitting opposite the patient, then places the fingers of the left hand on the patient's forehead, gently pushing upward the extremity of the nose with the thumb of the same hand. With the catheter held loosely between the thumb and forefinger of the right hand, the probe-pointed end is introduced very carefully, after being warmed and smeared with olive oil or vaseline. The end of the catheter should be pushed along the lower wall of the nasal passage until it touches the posterior wall of the pharynx, when it is turned obliquely outward, but not sufficiently to be in a horizontal position, and gently forced into Rosenmüller's fossa. By withdrawing the catheter and at the same time raising the probe-pointed extremity, the latter will be felt to glide over the posterior lip of the Eustachian tube. The point is then turned still further outward and upward, "so that the metal ring fastened to its posterior extremity is pointed toward the outer canthus of the eye of the same side" (Fig. 50). "The direction of the beak corresponds, as a rule, with the axis of the Eustachian tube" (Politzer). The catheter may be held in position by the surgeon, or, for this purpose, various clamps have been devised.

Second Method. By this method the posterior margin of the nasal septum serves as a guide. The catheter is introduced in the same way as in the first method, until the point reaches the posterior pharyngeal wall. Instead of turning the point outward, it should be turned inward, so that the extremity points toward the other Eustachian orifice. It is brought to a horizontal position, as determined by the metallic ring on the other end of the catheter. The catheter is then withdrawn until the curved portion reaches the posterior border of the nasal septum. The point of the catheter is now made to describe a complete semicircle by moving its point downward along the velum palati and then outward. It should thus enter the pharyngeal orifice, and be inserted afterward in the tube in the same manner as by the first method. Any action of the muscles of these parts that pushes the point of the catheter backward or throws it out of position will interfere with the success of this method. It is occasionally impossible to effect an entrance into the tube by either of these methods, and when both have failed it is frequently possible to successfully catheterize the tube by resorting to a modification of the last described method, as follows:—introduce the catheter as in the first method, carrying the tip well down into the pharynx, and when it has reached the posterior wall draw it forward without altering its plane until the curve is felt to impinge on the velum, then turn it up and out when the tip will be found to have slipped into the orifice of the tube. Considerable experience is necessary to practice this method successfully, but when once proficient in the other methods this one will be found very simple and effective in difficult cases. Before the introduction of the catheter the external extremity should be connected with the Politzer bag by means of a piece of rubber tubing about a foot in length, and the bag should have an aperture on the side which can be closed by the thumb of the surgeon when it is compressed, so that it will be possible for air to enter the bag again without the necessity of disconnecting the tip of the Politzer bag after each compression of the bag, a procedure that is usually extremely disagreeable to the patient.

I prefer in adults, catherization to the inflation of the ear by Politzer's method, whenever practicable, for several reasons: 1. The air enters the middle ear much more directly, and much more is accomplished by this method when it is carefully performed. 2. Very frequently it is necessary to force air into only one middle ear. Politzer's method should always be employed in the case of children and nervous individuals.

Before inflating the ear the drumhead should be examined, to see if atrophic changes may not have made it very thin. During the first compression of the air-bag very little force should be used. I have seen the drumhead ruptured by Politzer's method, when sufficient gentleness was not used, in a case in which the drumhead had become very thin.

The obstacles to the introduction of the catheter are various pathological processes that involve the nasal passages, such as hypertrophic catarrh, polypi, adenoid growths, and congenital deformities of the nasal septum and spongy bones. In acute inflammation of the middle ear, with swelling of the orifice of the Eustachian tube, catheterization is difficult and painful, as well as in some individuals in whom its accomplishment is prevented by spasmodic coughing or vomiting. When catheterization is impossible, owing to constriction of the nasal passages, air has been forced into the middle ear by the introduction of a catheter through the opposite nasal passage. Various catheters have been devised for this purpose, the method having first been advocated by Deleau in 1827.

The diagnostic tube should be used, as in Politzer's method, to determine the permeability of the Eustachian tube, as it is unwise to rely on the statement of the patient.

TESTS FOR HEARING.

The tests for the hearing-power are of the highest importance, for by such means the surgeon is usually enabled not only to locate the seat of the trouble, whether in the middle or inner ears, but also to note the course of the disease and the results obtained by treatment. The ear perceives sound-waves communicated to it through the air as well as vibrations transmitted through the cranial bones, so that it is most important in all cases to make separate tests of this power of perceiving these sounds.

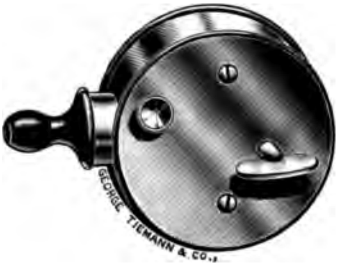
The watch, preferably a stop watch, and Politzer's acoumeter are generally used for determining the acuteness of hearing for sound waves transmitted through the air to the drumhead. It is best to have two watches for this purpose, the tick of one being higher than that of the other. First of all, the distance heard by the normal ear is determined and found to be, for example, fifty-six inches. This number will represent the denominator, so that if a patient hears the watch at ten or twelve inches his hearing-distance for the watch should be recorded as being ten-fifty-sixths or twelve-fifty-sixths of the normal distance. The patient's normal ear should be carefully stopped by inserting the moistened finger into the meatus; then the watch should be held at the normal distance from the affected ear and gradually brought toward it. The patient's eyes should be closed. It is well also to let the patient hear the watch tick before commencing the test. If the watch is placed in contact with the ear and gradually moved further away, the patient will hear the tick at a much greater distance than if the reverse is done.

As all watches vary very much as to the pitch and intensity of sound, tests made in this way are necessarily unsatisfactory. For this reason Politzer has devised an acoumeter (Fig. 52, 8), which consists of a horizontal steel cylinder, 28 mm. long and 4.5 mm. thick, connected by means of a tightly fitting screw with a perpendicular vulcanite column, at the superior and inferior extremities of which are two semicircles for holding the instrument, the forefinger being placed in the upper and the thumb in the lower one. A percussion hammer is placed just above the attachment of the cylinder, being fastened in an oval orifice of the vulcanite column. This hammer, falling upon the steel cylinder, produces the sound. The posterior short lever of the hammer, when pressed, is not allowed to go beyond a check, which consists of a soft India-rubber plate, so that the hammer always falls the same height and should produce the same sound. There is a hole in the vulcanite column for the insertion of a pin (Fig. 52, 8) having a round metal plate attached. This pin is inserted and applied to the temple or mastoid process, in order to determine sound vibrations through the cranial bones, and also in cases of extreme deafness, when it is placed in contact with the external meatus. The hearing-distance for the acoumeter should be measured by means of a tape-measure, or, better still, the number of feet and inches should be marked on the wall or floor. The only objection to this instrument is the fact that it is heard by the normal ear at a distance of forty-five feet, so that in cases of slight deafness it is better to make use of the watch. The patient's hearing-power for speech should always be tested, viz., for ordinary conversation as well as for the whisper. Investigations made by Oscar Wolf go to show that vowels are generally perceived at a greater distance and more readily than consonants, and especially words in which the vowels a, e, and i occur. Frequently in patients the hearing-power for the watch is very good, while conversation is heard with difficulty, and *vice versa*. Whispered speech is heard by the average normal ear in an absolutely still room at a distance of about fifty feet. It should be remembered that the hearing-power in a patient is subject to great variations, not only on different days, but on the same day and frequently it varies with the condition of the weather. In those affected with atrophic catarrh this is particularly noticeable, the auditory nerve becoming fatigued in a very short space of time, even while the tests for hearing are being made. Note should be made in taking the history of a case as to whether the patient hears loud, medium, or ordinary tones of speech, and whether he hears the voice of a child, woman or man best, assuming the pitch to be high, medium, or low respectively. Tests made with the voice are not wholly satisfactory, as it is difficult to raise the voice to the same pitch and give the forced whisper uniform intensity at each examination. Each ear should be tested separately, and the ear being examined should be directed toward the surgeon, while the other one should be closed with the moistened finger. With eyes shut so that he cannot see the lips of the examiner, the patient should be asked to repeat the words spoken by the surgeon, so as to make the test an accurate one.

BÁRÁNY'S NOISE APPARATUS.

Bárány has devised a noise apparatus (Fig. 51) for detecting unilateral deafness, which consists of a hammer, worked by clockwork, which strikes a membrane, and the sound from this is conducted to the ear by means of a tube which fits into the external auditory canal. No extraneous sound can be perceived by the ear in which it is inserted on account of the loud noise made by the hammer. When this apparatus is applied to one ear, it is possible to test the hearing of the other. With the latter, if normal, it is possible to hear conversation at a distance of two or three yards, and whispered voice at a distance of one yard. No sound will be heard at all in the ear under investigation, if the patient be completely deaf on that side.

FIG. 51.

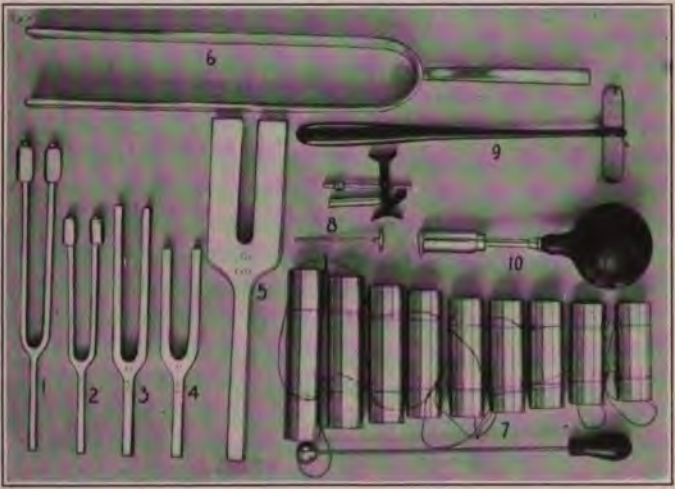


Bárány noise apparatus.

Besides the watch and acoumeter, the aural surgeon should be equipped with (1) several tuning-forks, usually three in number, C—128, C^2—512, C^4—2048 (Politzer), or better still, Hartmann's series of five forks C—C^4 (Fig. 52), (2) König rods, (3) a Galton whistle,

(4) several shrill whistles and musical instruments for testing the hearing of those who are extremely deaf. Experiments prove that low-toned tuning-forks, when vibrating, are heard better when held close to the ear than the high ones in cases of labyrinthine disease, while in middle-ear affections in which there is considerable inability to hear speech, low-toned tuning-forks are but faintly heard. It is well to have clamps attached to the extremities of the forks to prevent overtones. A fork should never be struck with or against a hard substance of any sort. A soft rubber percussion hammer such as shown in Fig. 52 will yield a pure tone.

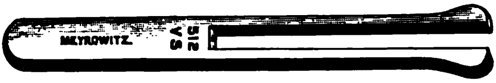
Fig. 52.



1-5. Hartmann's series of tuning-forks. 6. Politzer's low fork. 7. König's rods with hammer. 8. Politzer's acoumeter. 9. Hammer for striking forks. 10. Galton whistle.

By means of the tuning-fork a diagnosis can usually be made between disease of the middle and internal ears. In a normal case the tuning-fork, when vibrating and held close to the ear, will be heard more distinctly and louder than when placed against the mastoid process or on the side of the skull, the proportion being about two to one in normal hearing. In other words, the aërial conduction will be better than the bony conduction. If the finger is inserted in the external meatus, the sound will be intensified on the closed side when the tuning-fork is placed against the mastoid process or on the top of the head or against the teeth. The same is true of disease involving the external or middle ear. In a case of deafness, when it is found that a patient hears the tuning-fork better by the air than by the bone, it is fair to assume implication of the sound-perceiving apparatus; and when the bone-conduction is lost, it is certain that labyrinthine disease exists. Where one tuning-fork alone is used, the tuning-fork of Blake, 512 v. s. (see Fig. 53), is to be preferred. As a general rule, although there are exceptions, the higher tuning-forks are heard much better by aërial conduction than the lower ones in cases of disease of the middle ear.

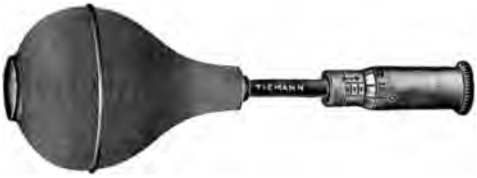
FIG. 53.



Blake's tuning-fork.

The Galton whistle (Fig. 54) is especially suited for testing the perception of the high notes, and consists of a cylindrical whistle. By turning the screw the note can be changed, and around the side of the whistle is a scale to show the numbers. The whistle has a com-pass of more than the three highest octaves, with about 6000 to 80,000 vibrations per second. In some patients tone perception for certain notes of the musical scale is diminished or entirely lost. Besides the Galton whistle, the König rods will be found particularly useful. They consist of rods or cylinders of steel, which are of different lengths, producing vibrations of from 20,000 to 80,000 in the second, with intervals of 5,000 vibrations. They are suspended at each end by a loop of fine wire or silk thread and struck with a steel hammer as shown in Fig. 52, 7).

Fig. 54.



Galton whistle.

The power of perception of sound transmitted through the cranial bones becomes very much diminished in old age. According to Politzer, after the sixtieth year the cases are rare in which a low-ticking watch is heard through the cranial bones.

Rinné's Test is a relative duration test, and is based on the fact that, normally, air conduction is about twice that of bone. It consists in placing a vibrating tuning-fork against the side of the skull or mastoid process. When the sound is no longer perceived by bone-conduction the fork should be held close to the auricle without again striking it. If heard again, which is the case in the normal ear, this is called the *positive Rinné* test. The reverse is called the *negative Rinné* test. The test is of particular value in cases of considerable deafness due to middle-ear affections, the negative Rinné test being marked in these cases unless there is implication of the labyrinth. In middle-ear affections in which the deafness is slight, Weber's test is more accurate.

Weber's Test. A vibrating tuning-fork, usually of 512 v. s., is held on the median line of the skull, or on the forehead just above the nose, or against the teeth, or on the median line of the lower jaw, and the conclusion can be reached as to whether the bone-conduction is better on one side or the other. With both Weber's and Rinné's tests in ordinary cases of deafness a diagnosis should be made between disease of the middle ear and labyrinth.

Bing's Test. Bing's Test is an additional or modified Weber's test for determining obstruction in the middle ear, and depends on the so-called secondary perception of a note. For example, if a vibrating fork is placed on the skull and the tone is perceived by the patient, he is directed to signal when the fork is no longer heard; the canal is then to be closed by the finger without undue pressure, when the note should be heard again if the middle ear is free from obstruction.

Schwabach's Test is an actual duration test in which Hartmann's series of five tuning-forks is used. The forks are known as $C = 128$, $C^{I} = 256$, $C^{II} = 512$, $C^{III} = 1024$, and $C^{IV} = 2048$ d. v. s.—double vibrations per second. The method consists in ascertaining the number of seconds the patient can hear each fork by air-conduction (A. C.) and by bone-conduction (B. C.). For example, a fork (say C.) is held close to the external auditory meatus; the time is noted the instant the vibrating fork is held near the meatus, and again when the patient raises his hand to indicate that the fork is no longer heard. This will give the time for A. C. The same fork is then vibrated again, the end is held firmly against the skull over the antrum of the same side, and the time taken and recorded as before, which will represent the time of B. C. for the C fork on that side.

The result of this test in a case of normal hearing is shown in the following table:[1]

	C	C^{I}	C^{II}	C^{III}	C^{IV}
A. C.	25	15	33	32	22
B. C.	13	7	13	13	14

GELLÉ'S TEST is employed for the purpose of determining the mobility of the ossicular chain, and depends upon the fact that compression of the air in the external auditory canal will fix the stapes in the oval window, provided there is no opening in the drum membrane; or, if there is a perforation, the Eustachian tube is closed.

The test can be simply performed by inserting lightly the moistened finger into the external auditory canal while holding a vibrating tuning fork on the mastoid process, preferably over the antrum. If the fork is heard and the ossicular chain is in normal condition, compression of the air in the canal by forcing the finger into it will cause the fork to cease to be heard, but the vibrations will again be apparent when the air is released.

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[1] After John E. Sheppard, M.D., in American Text-Book of Diseases of Eye, Ear, Nose, and Throat.

A Siegle's otoscope (Fig. 42) can be used to advantage for compressing the air in the canal in performing this test.

If no difference in the sound of the fork is appreciated by the patient between compression and release of the air in the canal, it is fair to assume that the mobility of the ossicles is impaired or lost.

Occasionally it happens, although rarely, that the vibrations of a tuning-fork sound one-quarter or one-half a tone higher in one ear than the other (*diplacusis*). This is probably due to increased tension of the labyrinthine fluids produced by pressure of the stapes, or it may be due to congestion of the labyrinth itself. Only one ear is apt to be affected, and it is an easy matter for the surgeon to determine which one it is by holding the tuning-fork close to his own ear, so that when the patient sings the note heard he recognizes which side is affected.

I have observed this phenomenon in both middle-ear and labyrinthine diseases. In the former the treatment consists of inflation of the middle ear by means of the catheter, and of appropriate treatment for the naso-pharynx, if this region is affected. In labyrinthine disease I have seen it occur in a patient who had a severe attack of influenza. In this case the middle ear was not involved, and the symptoms persisted for a long time.

A case of otitis media catarrhalis chronica at the Vanderbilt clinic;

	C	C^{i}	C^{ii}	C^{iii}	C^{iv}
A.C.	0	0	7	12.5	10
B.C.	18	7	10	14	0

A case of labyrinthine disease at the Vanderbilt clinic;

	C	C^{i}	C^{ii}	C^{iii}	C^{iv}
A.C.	0	6.5	4	3	5
B.C.	6	0	0	0	0

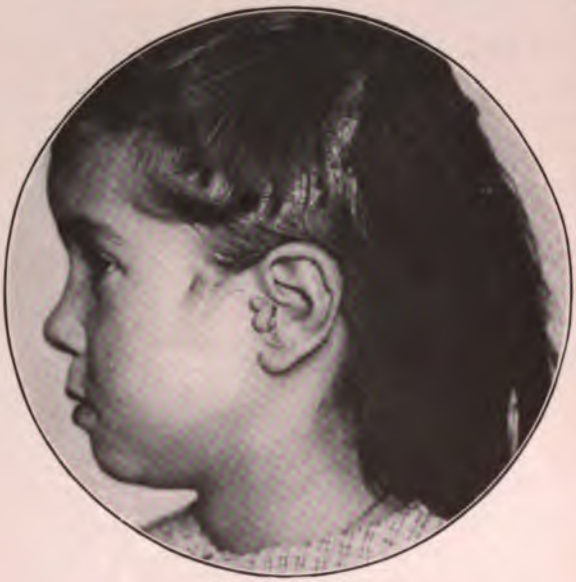
CHAPTER III.

DISEASES OF THE AURICLE.

MALFORMATIONS.

MALFORMATIONS of the organ of hearing may exist alone or be associated with malformations of other organs, such as want of development of the eye or side of the face on the same side. There may be congenital

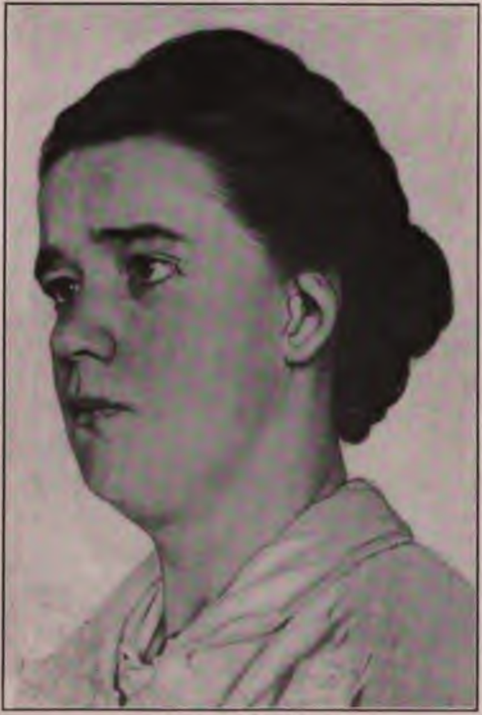
FIG. 55.



Case of polyotia.

excessive development of the auricle, the development of two auricles (polyotia), or so-called auricular appendages. (See Figs. 55, 56 and 57.) According to Cassells, excessive development is usually limited to the auricle itself, while want of development is apt to occur with defect of development of the external meatus and tympanum, less frequently with defect of the internal ear. There may be entire absence of the auricle, mal-

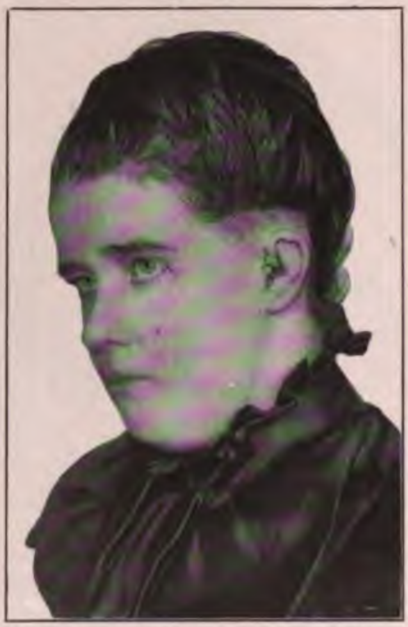
FIG. 56.



Case of polyotia.

formation or absence of the different portions of the ear, viz., the lobule, helix, and antihelix. Imperfect development (microtia) is more frequent (Fig. 58). The auricle is generally out of place in such cases, and may resemble a cat's ear; the lobule is at times adherent to the skin.

FIG. 57.



Showing result of operation for polyotia.

I have reported a case[1] of malformation of the auricle in which I performed a plastic operation for the cure of the deformity, which occurred in a girl of fourteen years. The auricle was attached somewhat higher than the normal one on the other side, and hung down as shown in Fig. 59. The hearing-distance was considerably affected. The operation consisted in the removal of an elliptical portion of the integument and connective tissue, three-quarters of an inch in width and two and a quarter inches long, from the posterior and upper portions of the auricle, commencing the incision at the beginning of the helix and carrying it along the fold at the attachment of the auricle almost to the lobule, so as to leave as little scar as possible. The integument and connective tissue having been dissected away, the cartilage was bent back upon itself, but not divided, and the different folds and depressions

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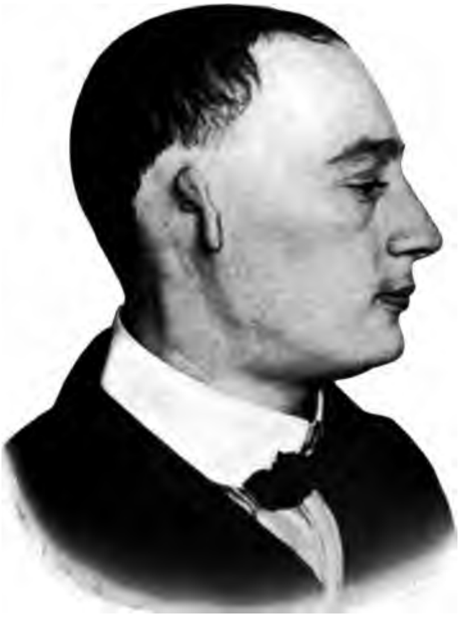
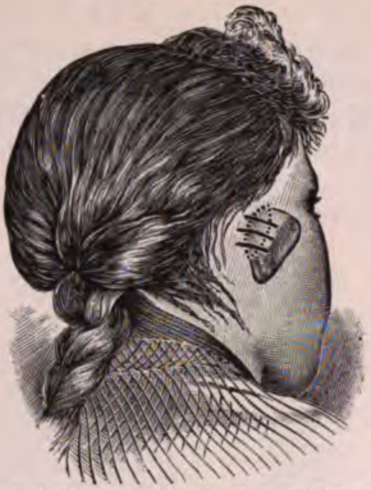
[1] Archives of Otology, 1890, vol. xix. No. 1.

FIG. 58.



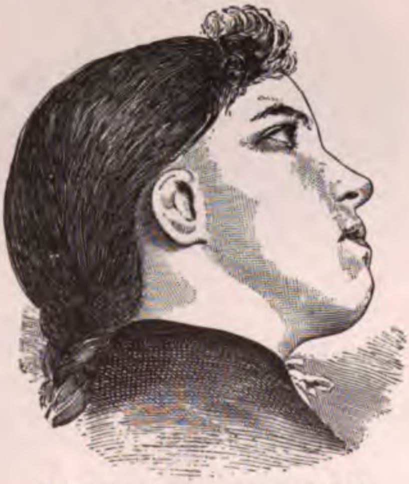
Case of microtia.

FIG. 59.



Deformed auricle before operation, showing elliptical incision with sutures in position.

FIG. 60.



Deformed auricle. (After operation.)

on the auricle were brought out again by suturing the raw edges of the wound. It was necessary to keep a pad with an elastic band over the ear for a short time. The result was excellent and the hearing-distance was improved (Fig. 60). This operation may likewise be performed in cases of very prominent auricles. Congenital deformities are, according to Virchow, due to early disturbances in the closure of the first branchial cleft, and are often associated with cleft palate and other forms of arrest of development in the facial bones.

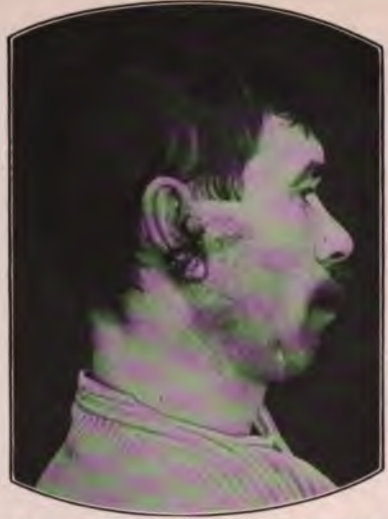
A *fistula auris congenita* is a short, blind canal, with a lining of epithelium which secretes a whitish or milky fluid. The orifice is usually visible just in front of or below the tragus, but there is no communication with either the tympanum or the external auditory canal.

INJURIES OF THE AURICLE.

Injuries of the auricle are not frequently observed by the aural surgeon, as patients so afflicted are more likely to consult the general surgeon. Cuts, bruises, burns, occasionally occur, and should be treated according to the usual surgical procedures. A case has been reported in which the entire auricle was bitten off by a horse. A severe case[1] of lacerated wound of the auricle (Figs. 61 and 62) came under my observation a short time ago. The patient, a stableman, thirty-nine years old, while working in an elevator, fell and struck the side of his head against a wagon. The lower third of the auricle was almost torn off and the wound extended into the cartilaginous canal and tragus. From fifteen to twenty-five stitches were required to bring the edges of the wound into

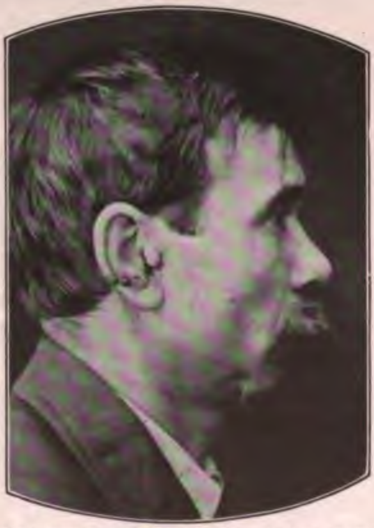
[1] N. Y. Med. Record. Nov. 25, 1911.

Fig. 61.



Lacerated wound of right auricle. (Before operation.)

Fig. 62.



Lacerated wound of right auricle. (After operation.)

apposition. The cartilage was not included in the sutures, only the integument. Four days later the sutures were removed, and the wound had healed by first intention. Traction on an earring occasionally is the cause of a cleft lobule. The wearing of brass earrings at times sets up a severe inflammation of the lobule, and in a case that came under my observation there was intense inflammation, followed by sloughing of half of the lobule on each side. Since foot-ball has become so popular a game, injuries of the auricle are of more frequent occurrence. In stitching an incised wound, it is well not to include the cartilage, but simply to carry the sutures through the integument; otherwise there is a liability that necrosis of the cartilage may occur.

HÆMATOMA AURIS, OR OTHÆMATOMA.

An hæmatoma is the name applied to a swelling, of a bluish-red color, which is due to a sudden effusion of blood between the cartilage and perichondrium, and which is usually caused by a sudden blow on the ear, and is of frequent occurrence among boxers. Such a tumor is at times observed among the insane, and formerly it was supposed to be due to ill-treatment. This may have been the case in some patients, but it is more probable that the effusion in such instances is caused by tissue-changes in the auricle itself. By severing the restiform body in animals, Brown-Séquard was able to produce a hemorrhage in the auricle. The swelling, when observed immediately after its appearance, is of a bluish-red color, roundish in shape, somewhat hard, but with no distinct point of fluctuation. In some instances it is quite soft to the touch. Othæmatoma occurring spontaneously is rarely of large size, while in cases due to traumatism the swelling may involve the entire auricle, including both surfaces, and occlude the external meatus, thus producing considerable deafness. Generally, the swelling involves the concha and fossæ of the helix and antihelix, but not the lobule. In othæmatoma due to traumatism there are usually pain, heat, and more or less tenderness. The resulting deformity depends very much on the extent of the hemorrhage and the injury done to the cartilage. Othæmatoma should not be confounded with perichondritis auriculæ, as the former occurs suddenly, and is generally caused by a blow.

As to the treatment, when the swelling is slight, the application of cooling lotions, such as the lead and opium wash or Burow's solution—viz., ℞ Liq. alumin. acetat., 12 parts; plumbi acetat., 5 parts; and distilled water, 100 parts—may cause the hæmatoma to disappear. It is much better, however, especially when there is much swelling, to incise the tumor at once and turn out the blood-clots, and treat the wound antiseptically. In a case treated recently in this manner the cavity of the tumor was thoroughly washed out with a 1 : 10,000 bichloride solution, and the edges of the wound sutured except at the lowest point, where a small tent of iodoform gauze was inserted. A pad and bandage were applied, with the result that there was little if any deformity. Massage is recommended by some, but should be used cautiously.

PERICHONDRITIS AURICULÆ.

This is a term applied to an acute inflammation of the perichondrium, giving rise to a swelling which is generally hot and painful to the touch, of a darkish-red color, and varying much in size in different cases. It is usually found on the anterior aspect of the auricle, and may close the external meatus, and thus interfere seriously with the hearing on the affected side. If an incision were made in one of these tumors, its cavity would be found filled with a thick yellowish fluid, less frequently with pus, and only occasionally are there observed a few red blood-corpuscles. The perichondrium becomes detached from the cartilage, and the latter and the surrounding parts are greatly inflamed, leading to more or less thickening of the tissues, with deformity of the auricle. If an incision is made in the tumor and a probe introduced, the cartilage will frequently be found denuded and roughened. The inflammation occasionally has its starting-point in the external meatus, and generally involves the concha and fossa helicis, but does not extend to the lobule.

Perichondritis should be distinguished from hæmatoma (1) by the fact that traumatism is not apt to be the cause; (2) in perichondritis the inflammatory symptoms are more severe and the development of the tumor is more gradual; (3) the contents of the swelling are either a clear, thick, syrupy fluid, or occasionally pus, while in othæmatoma there is always blood at first. In the later stages a differential diagnosis becomes more difficult, as an othæmatoma may also contain a clear syrupy fluid or pus. The deformity is quite marked in some cases of perichondritis, although in some few instances it may be but slight. The duration of the disease varies from two to ten weeks. In the early stage the treatment should be entirely antiphlogistic, consisting in the application of cooling lotions, lead and opium wash or Burow's solution. Later, the tumor should be incised as soon as fluctuation is detected, and thorough aseptic precautions should be observed. A pad and pressure bandage will be found beneficial in some cases as well as massage. Some authors advise the use of a hypodermic needle for the purpose of withdrawing the fluid, and afterward injecting into the cavity a solution of tincture of iodine one part, water two parts. After allowing it to remain for a few moments it should be withdrawn by means of a syringe.

CYSTS.

Under this heading cases have been reported in which tumors in the auricle have developed without apparent signs of inflammation. The contents consist of a clear fluid without any flocculi or blood-corpuscles. As for a differential diagnosis between cysts and perichondritis, Hartmann considers that "inflammatory phenomena are altogether absent in cases of cysts, while perichondritis is accompanied with redness, heat, and severe pain. The appearance of the secretion in perichondritis is similar to that in cysts, yet the fluid has an unclean, purulent character from the admixture of pus-corpuscles." Certain changes which predispose to the formation of sanguineous tumors are found in the auricle, especially in the dyscrasic and insane as well as in the aged. Hartmann believes that the process of softening which has been described by different authorities is not only the predisposing cause of hæmatoma, but is also to be regarded as a preliminary stage of simple cyst-formation. Cases of hæmatoma due to traumatism occur quite frequently, however, where there are no changes in the cartilage.

HYPERÆMIA.

This is observed in some cases as a result of frostbite or eczema, or other cutaneous diseases; also in patients of a neuropathic and hysterical temperament, and in those suffering from valvular disease of the heart. Hyperæmia may also be due to the action of heat or cold. The application of poultices may also produce an hyperæmic condition and lead to the formation of small abscesses. As to treatment, the cause should be removed, if possible, by constitutional measures. Locally, the lead and opium wash or Burow's solution is to be recommended.

DERMATITIS.

Inflammation of the skin of the auricle may be due to the sting of insects, the effects of heat or cold, or to blows, falls, piercing the ears for earrings, and mechanical irritation and scalding. The inflammation may be very slight, or severe enough to lead to gangrene. In the early stage antiphlogistic treatment should be employed, viz., by making applications of cooling lotions.

ERYSIPELAS.

According to some writers, erysipelas affecting the auricle may occur as a primary or idiopathic disease from cold or other causes, but more frequently it is due to an extension of the inflammation from the surrounding parts. Leech-bites sometimes cause erysipelatous inflammation, as well as injuries to the walls of the external auditory canal, in persons whose general health is impaired. In the light of modern science, it is now generally admitted that erysipelas is due to invasion by Fehleisen's streptococcus erysipelatis.

Two cases[1] of erysipelas of the auricle and face, occurring as a complication of disease of the ear and secondary to it, came under my observation. In one the patient had an acute suppurative otitis media, and two weeks later the antitragus became tender and inflamed. On the following day the entire auricle was involved in an erysipelatous inflammation, and was twice its natural size. The auditory canal was not involved, but the disease extended over the scalp and face. When the disease first appeared the discharge from the ear became scanty. The patient had a chill at first, and the temperature varied from 100.5° to 104.5°. He complained also of dizziness. In the second case erysipelas of the auricle followed an attack of acute suppurative otitis media and furunculosis of the external meatus. The erysipelatous inflammation spread from the tragus of the left ear to the scalp and face, and involved the right ear as well. This patient had a temperature ranging from 102.4° to 104.6°. In both cases the pulse was slow and full, and the general health was below par. In the second case the erysipelas lasted for a week. It is also probable that erysipelas of the pharynx may spread to the face by means of the Eustachian tube, tympanum, and external auditory canal. It occasionally occurs as a complication of mastoid disease.

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[1] Archives of Otology, 1887.

As to treatment, I have seen excellent results follow the administration of drop-doses of tincture of aconite and tincture of belladonna. Locally, the lead and opium wash or Burow's solution should be applied, or 25 to 50 per cent. of ichthyol ointment.

A certain proportion of cases will do well under the application of pure carbolic acid and alcohol, but this method must be employed with great care, and as follows: paint small areas of the part affected with pure carbolic acid, under perfect control as to dripping and running on the skin where undesirable. Allow the acid to act until the skin whitens, and then immediately kill all the acid with 95 per cent. alcohol. Continue the application of the acid followed by alcohol until the entire affected area has been treated and one-half inch of healthy skin in addition. Any dressing subsequently applied should be bland and changed frequently.

As this affection is due to the streptococcus erysipelatis, vaccines have been used to combat its progress and hasten the cure. Stock vaccine is used, and generally that known as polyvalent is preferred, which is made up of a number of different strains of streptococcus. The initial dose recommended is from 10,000,000 to 20,000,000, given subcutaneously under aseptic conditions, at a point far removed from the affected area. On the second day 5,000,000 to 10,000,000 are injected, according to the severity of the disease, and after this 5,000,000, 10,000,000, or 20,000,000 on alternate days until the temperature has been normal for a week, assuming, of course, that the temperature is due to the complicating erysipelas.

The clinical symptoms are the guide to treatment, and the more severe the case the smaller the dose. The Hiss Leucocyte Extract[1] has been used by some otologists with success.

For further particulars in regard to this matter the reader is referred to works on Vaccine Therapy.

FROSTBITE.

If the auricle is frozen, the ear becomes yellowish white in color, and in extreme cases, if actually congealed, it may be brittle. To restore the circulation in the parts, the patient should be placed in a cool room, and friction applied, very gently at first, to the auricle with snow, and afterward with cold water. After the re-establishment of the circulation warmer water may be used. In favorable cases the circulation becomes re-established, but the auricle is apt to be sensitive for some time afterward. Where the auricle has been frozen and proper treatment has not been carried out, there may result severe inflammation, such as perichondritis, leading ultimately to gangrene. In the latter case amputation becomes necessary. Redness and burning of the auricle resulting from frostbite should be treated with cooling lotions; when chronic, by the local application of iodized collodion. When the skin is excoriated, equal parts of zinc oxide and boric acid should be dusted over the parts. When ulcerations occur as well as gangrene, general surgical procedures should be adopted.

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[1] Hiss and Dwyer: New York Med. Record, September 13, 1913.

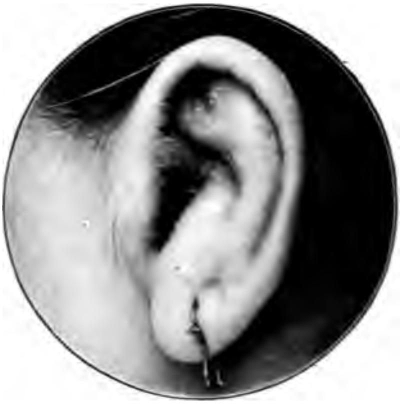
ECZEMA, ACUTE AND CHRONIC.

Eczema affecting the auricle is very similar to the disease occurring elsewhere, except that the hearing is liable to be affected, especially when the auditory canal and membrana tympani are involved. The varieties are the erythematous, vesicular, pustular, and squamous. The disease may be acute or chronic, although the former is more usual; it may attack all ages and both sexes, but is more frequent among children and females. Eczema occurring about the pinna may be idiopathic or secondary to that occurring about the head or face. In the acute idiopathic variety one or both auricles may be attacked, or the disease may be limited to one side. The auditory canal may or may not be involved. In the acute stage the ears are usually swollen, the seat of much burning and itching, and covered by vesicles or pustules, which may become dry and thus envelop the auricle with unsightly crusts. The auricle, in consequence, becomes deformed and unshapely; the meatus may be closed by the collection of crusts or through swelling of the parts, and, as a result, the hearing becomes impaired, so that a sense of fulness in the ears and tinnitus are often complained of. Painful rhagades may be found behind the ear. In chronic cases the auricle may be considerably thickened, leading to deformity and stenosis of the external meatus (Fig. 63). In children eczema is aggravated by uncleanliness, by picking at the ear, and by the use of unsuitable head-coverings, by which means the ears are pressed against the side of the head, thus causing an *eczema intertrigo* through friction of the surfaces. Anything that tends to impair the general health, such as dentition, will act as an exciting cause.

An artificial eczema is frequently due to the instillation of improper ear-drops, an excoriating discharge from the ear, the effects of heat and cold, and, especially in children, to pediculi about the head.

Particular attention should be paid to the patient's general health. The urine should be examined for albumin or sugar. Diuretics and alkaline waters are required for those of a gouty or rheumatic diathesis. In scrofulous children, cod-liver oil, syrup of the iodide of iron, and the compound syrup of the hypophosphites should be prescribed. In chronic eczema, Fowler's solution of arsenic should be administered. Naso-pharyngeal catarrh, or middle-ear disease, if it exists, should receive careful treatment, and the condition of the mouth should be noted, to see that there is

FIG. 63.



Case of chronic eczema following frost bite.

no dental irritation. As regards local treatment, the officinal zinc ointment will be found all that is required, the unguentum diachyli of Hebra or Lassar's paste: ℞ zinc. oxid., amyl., āā ʒij; acid. salicylic, grs. v; vaseline alb., ℥ss.—M. The crusts should first be removed with sterile olive oil and then the parts well rubbed several times a day with the ointment. When the auditory canal is invaded, the crusts and scales should be removed gently with curettes, and then the zinc ointment or Lassar's paste applied, or, what is better, the canal may be dusted with a powder composed of equal parts of zinc oxide and boric acid. Occasionally it will be necessary to remove the scales from the meatus by syringing; but, if possible, no water should be used. In eczema intertrigo occurring behind the ears, especially in children, the scales should first be removed by means of sterile cotton soaked in sterile olive oil or vaseline, and then powdered stearate of zinc or subnitrate of bismuth should be applied. Should the disease show a tendency to become chronic, especially if there is any thickening, the following ointment will answer well: Acidi tannici, ʒj; vaselini, ℥j.—M. Or the following: ℞ zinc. oxid., amyl., āā ʒij; acid. salicylic, grs. v; sulph. præcip. ol. rusci, āā grs. xxv; vaselin. alb., ℥ss.—M. In making applications to the external auditory canal, great care should be taken not to injure the membrana tympani. Another ointment for a dry and scaly eczema of the external meatus is the following: Acidi salicylici, gr. j; tr. benzoini, gtt. ij; ung. rosæ, ʒj.—M.

In such cases benefit will often follow the application of a solution of nitrate of silver, grs. x–xx to water ℥j, or of acetum cantharidis; but in painting the canal with the latter, great care should be exercised not to touch the membrana tympani. Ointments containing tar or white precipitate of mercury are occasionally indicated in chronic eczema.

The following skin diseases are also observed at times on the auricle, associated with the same diseases elsewhere on the body—viz., *herpes zoster, lupus, erythema, porrigo contagiosa, keloid, molluscum fibrosum, tinea tonsurans*, for the treatment of which the reader is referred to the standard works on dermatology.

Ossification of the auricle as a result of perichondritis has been reported, but is of very rare occurrence.

Deposition of the urates is noticed occasionally in the auricle of a gouty subject.

Herpes zoster, affecting for the most part the anterior surface of the auricle and the external auditory canal, has been described by Ramsay Hunt.[1] Involvement of the geniculate ganglion causes the severe pain and the herpes. When the motor fibres of the facial nerve are involved, facial paralysis occurs. In some cases loss of hearing is noticed while in other instances, in addition to deafness, other symptoms are vertigo, vomiting, a staggering gait and tinnitus.

TUMORS OF THE AURICLE.

Under this heading may be mentioned *abscess, atheroma or sebaceous cyst, fibroma, myxofibroma, malignant growths, dermoid cysts, warts, papilloma, angioma, lipoma, nævus maternus, aneurismal dilatation of arteries, and cornu cutaneum.*

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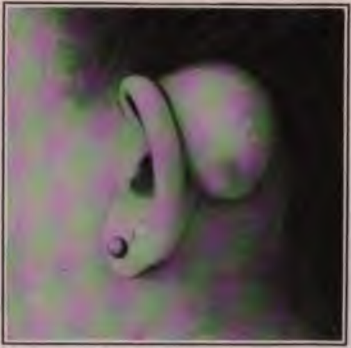
[1] Journal of Nervous and Mental Disease, 1911, and American Journal of the Medical Sciences, August, 1908.

Atheroma, or **Sebaceous Cyst**, is due to the blocking of a sebaceous gland and the rapid increase of its contents. It is usually found in the integument just behind the lobule and close to it, or in the lobule itself. The cyst should be removed with its sac entire, if possible. When the sac cannot be dissected out, the walls of the cyst should be curetted, so as to remove every trace of the sac as well as any purulent or cheesy matter. (Fig. 64.)

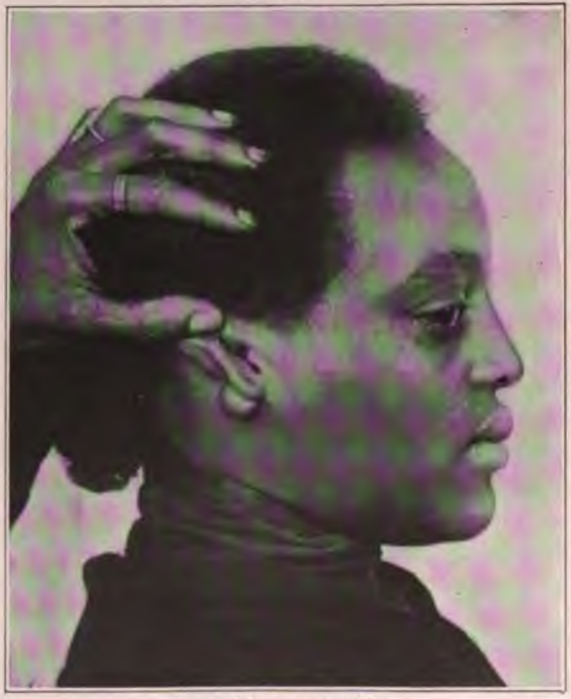
Fig. 64.



Case of atheroma.

Fibroma. Cases of fibroma are observed at times, the growth, as a rule, involving the lobule. The disease may affect one or both lobules, and is occasionally due to piercing the ears, and is found quite frequently in negro women. A fibroma is made up of fibrous connective tissue, with an occasional admixture of mucous tissue; it is of a round or globular shape, somewhat movable, and of more or less firm consistency. After total removal the tumor is not apt to recur. I have reported a case of a fibroma affecting the lobule of each auricle in the person of a girl, aged seventeen, who had had her ears pierced four years previously, and immediately afterward the lobules began to enlarge. Another case recently came to my attention at the Vanderbilt clinic of a negress, twenty years of age, who had a fibroma of each

F G. 65.



Case of fibroma of auricle.

lobule, the right one about three-eighths of an inch in diameter, and the left considerably smaller. Both tumors were on the posterior surface and appeared to have had their origin from scar tissue due to piercing the ears for earrings two years previously. The tumors did not appear to develop sufficiently for the patient to notice them until eighteen months later. (See Fig. 65.)

Dermoids occasionally occur. They have a capsule of connective tissue lined with epithelium and elements of the skin, including hair follicles and fine hairs. The contents consist of exfoliated epithelium, hairs, cholesterin crystals, fat and a liberal quantity of serum.

Epithelioma at times attacks the external meatus primarily but is more likely to spread to the canal from the auricle or face. It has been known to follow frost-bite of the pinna. In those cases in which excision has failed to effect a cure, the x-ray and radium have been used of late years with apparent success by some observers while others have met with failures, and it is too early as yet to draw any definite conclusions as to the value of either method of treatment in establishing a permanent cure.

The other growths sometimes noticed in the auricle, and previously mentioned, should be excised, if possible, and treated on general surgical principles. Among the less frequent tumors that are occasionally observed may be mentioned, *cylindroma,* or *myxoma cartilagineum,* originating in the cartilaginous *meatus,* and *enchondroma,* having its origin from the cartilaginous portion of the external auditory canal.

SYPHILITIC DISEASES.

Chancres and **Gummata** have been found on the auricle, but very infrequently.

TUBERCULAR SYPHILIDES on the auricle have been reported, and these may lead to deep ulcerations.

PAPULAR, PUSTULAR, and SQUAMOUS eruptions are observed, but usually in connection with similar eruptions about the scalp and forehead.

CHAPTER IV.

DISEASES OF THE EXTERNAL AUDITORY CANAL.

MALFORMATIONS.

EXCESSES of development occur among the malformations of the external auditory meatus, such as unusual dilatation and a double condition of the auditory canal. There may be two separate canals, or a blind canal behind the normal one.

Much more frequent, however, are the defects in the formation of the auditory canal which usually are associated not only with defects of the auricle, but also with defects of the middle ear, and frequently with arrest of development of the cranial bones. The canal may be very narrow or absent, with simply a depression where the meatus should exist. The contraction may be bony or membranous, usually the former. The hearing in such cases varies according to the amount of atresia, but even when there is complete occlusion, if the labyrinth is normal on the affected side, there will remain some hearing power.

As to the propriety of operating on such cases, the general opinion is decidedly against any such procedure, unless there is some urgent necessity for the operation, especially if the patient has one good ear. Even when there seems to be every indication that a bony canal exists beneath the integument, the surgeon will often be disappointed if he attempts an operation. When an operation is performed, a crucial incision should be made through the soft parts down to the bone, and a silver tube should be inserted, to keep the passage open. In such cases there is always difficulty in accomplishing this, as granulations form rapidly and have a tendency *to force* the tube out.

OTITIS EXTERNA DIFFUSA ACUTA, OR ACUTE DIFFUSE INFLAMMATION OF THE EXTERNAL AUDITORY CANAL.

Acute diffuse inflammation of the external auditory canal may occur as a result of the instillation of improper solutions into the ear, and in a case under my observation "St. Jacob's Oil" caused acute inflammation of the external meatus, as well as of the middle ear. Scratching the canal with hairpins and other such instruments, to relieve itching, frequently causes diffuse inflammation. Sea-bathing is another cause. As an idiopathic disease, I believe this affection to be extremely infrequent, although cases do occur, followed by suppuration, in which the middle ear is not involved. Diffuse inflammation of the external meatus is of common occurrence in cases of middle-ear suppuration when the discharge is acrid; also in cases of furuncular inflammation of the external auditory canal.

Symptoms. In the early stage the *meatus* is greatly congested, especially so about the bony canal and external layer of the drumhead. The cartilaginous portion may in some cases be so swollen that but little of the osseous canal is visible. The external meatus becomes very narrow from the swelling of the tissues, and the dermal layer, being white and sodden from a serous discharge, peels off, leaving the canal and drumhead extremely red and excoriated. Frequently the dermal layer peels off, and may be removed by syringing in the form of the canal. On microscopical examination of the dermal lining micrococci will be found. After removal of the finger-like tube the canal and drumhead will be found greatly congested and all landmarks of the latter will be absent, so that the boundary between the membrana tympani and canal is lost.

The *subjective symptoms* are radiating pains, especially when moving the jaw, and when the surgeon makes pressure on the tissues in front of the tragus. In some cases there are tinnitus and dizziness; in others, a sense of itching in the canal precedes the inflammation.

The duration of the attack varies from a few days to two weeks, or longer if the disease becomes chronic. The degree of deafness will depend very much on the severity of the inflammation. When the canal is very much narrowed and filled with dermal scales, or the outer layer of the drumhead is swollen, there will be considerable interference with the function of hearing. Instead of recovery ensuing in due time, there may be several exacerbations, or ulceration may develop on the drumhead, leading to perforation of the membrane from without inward; or ulceration may occur on the osseous canal, and granulations may spring up from the exposed bone. If the disease becomes *chronic*, there is usually a thick, offensive discharge, containing scales of epidermis and pus-cells with micrococci. As the drumhead appears dullish red, difficulty will be experienced in making a differential diagnosis between diffuse inflammation and chronic otitis media purulenta, especially if there are granulations on the drumhead. There may be granulations and ulcerations on the walls of the canal, which may lead to the formation of membranous bands, thus causing atresia of the external meatus.

As a result of chronic diffuse inflammation, there may follow hypertrophy of the cutis or periostitis of the bony meatus, as well as caries and necrosis. In some instances the inflammation may extend to the parotid gland.

Treatment. In acute cases in which the inflammation and pain are not severe, a saturated solution of boric acid should be instilled frequently into the ear. When the inflammation is severe, however, the artificial leech should be applied close to the tragus, and drops of a 4 per cent. solution of cocaine in sterile oil, or a 10 per cent. solution of opium in sterile oil, should be used. If the canal becomes very narrow from swelling, free incisions should be made through the skin and periosteum. After the acute symptoms have subsided, especially if there is much discharge, and after removing all pus and scales from the meatus by means of the syringe and curettes, boric acid powder should be insufflated, or a powder containing equal parts of boric acid and zinc oxide. Urbantschitsch has used with excellent results an ointment containing thigenol 3 to 4 parts; lanoline, vaseline, each 10 parts. It has a cauterizing effect so that its action must be watched. When the disease has become chronic, and especially if there are granulations, alcohol drops (either pure alcohol or diluted one-half with water and containing boric acid, grs. xx to ℥j) should be used. In some cases in which granulations arise from bare bone, these should be removed with a sharp spoon and the bone scraped. In other cases the granulations may be cauterized with nitrate of silver or chromic acid fused on the end of a probe.

OTITIS EXTERNA CIRCUMSCRIPTA ACUTA, OR ACUTE CIRCUMSCRIBED INFLAMMATION OF THE EXTERNAL AUDITORY CANAL, OR FURUNCULOSIS.

This is quite a common complaint, especially among those who are suffering from impaired health, and it is occasionally observed among diabetic patients. Furuncles, however, are found at times in the case of those who are strong and healthy, but children are usually free from them. Mechanical irritation of any kind may be the exciting cause of a furuncle, such as too frequent syringing, scratching the ear with a hair-pin or some other instrument, to relieve itching of the external meatus. Furuncles may develop during the course of chronic purulent otitis media, or as a result of chronic eczema of the external meatus. There is undoubtedly a micro-organism present to account for the inflammation, most frequently the Staphylococcus pyogenes aureus and albus, which, according to Loewenberg, finds its way into the superficial layers or deeper parts of the skin by means of the hair-follicles or glands. The seat of the inflammation is, as a rule, in the cartilaginous portion of the external auditory canal.

Symptoms. Pain is a prominent symptom, varying in intensity according as to whether the furuncle is seated in the superficial layer of the cutis or in the deeper parts. The patient usually experiences great pain on moving the jaw and on making slight traction upon the auricle. The pain is generally very severe, and keeps the patient from getting any rest at night. There is usually loss of appetite, and fever may or may not occur. When the drumhead is involved, or when the lumen of the canal is closed by a furuncle, tinnitus and deafness will be complained of. Another cause of deafness is the blocking up of the meatus with pus and scales. The seat of the furuncle is usually on the anterior inferior wall of the cartilaginous meatus, although there may be several furuncles. When situated on the anterior wall, pain is usually complained of when pressure is made on the tragus. When on the posterior wall, however, there are very often considerable swelling and redness of the tissues over the mastoid process, which symptoms are frequently mistaken for mastoid disease if a careful examination of the external auditory canal is not made.

In a case recently seen in consultation, which presented certain symptoms of mastoid disease, the tissues were hard, brawny, and œdematous, not only over the mastoid process, but also in the neck. The cartilaginous canal was slightly red and tender, and its calibre somewhat diminished. No furuncle could be seen. There was some redness of Shrapnell's membrane. The hearing was but slightly affected. The patient was a man, sixty-five years of age, broken down in health, and he had lately had several boils on the back of his neck. The hard and brawny tissues behind the auricle were freely incised down to the bone. A few days later a furuncle developed in the cartilaginous portion of the external meatus, proving the case to be one of furunculosis of the external auditory canal.

After from three to five days the furuncle will break down and discharge pus; the more superficial the furuncle the more readily will it discharge into the meatus. Occasionally the furuncular inflammation will subside without bursting. After evacuation of the pus there is usually immediate relief, viz., the pain and other symptoms subside. This is not an invariable rule, however, for at times exacerbations occur, and other furuncles follow one another as a result of the invasion of the follicles or glands by the staphylococci. At times there will remain redness of the canal and infiltration of the tissues after the abscess has subsided, and occasionally granulation-tissue springs from the opening in the furuncle, which necessitates its removal with the curette or snare.

There is usually no difficulty in making a diagnosis of furunculosis, especially if a probe is used to touch the parts. A polypus is sometimes mistaken for a furuncle, and so is an exostosis, but the latter when touched with a probe will seem hard and bony.

Treatment. In the early stage, especially if the pain is severe, the artificial leech should be applied, and in some cases Leiter's coil will be found useful. Good results frequently are obtained by soaking a tampon of cotton in a solution of menthol 1–5, or carbolic glycerin 1–40, and introducing it in the canal to cause pressure. The tampon is kept in place for a day if possible and then should be removed. The following solution of Burow when warmed and dropped into the ear will often abort the disease; ℞ Liq. alumin. acetat., 12 parts, plumbi acetat., 5 parts, and distilled water 100 parts. An excellent method is to pack the external auditory canal with a narrow strip of gauze soaked in a 4 per cent. solution of aluminum acetate, and then to have the patient keep the gauze constantly moist by dropping some of the same solution into the canal. When the furuncle is deep-seated and very painful, an early and free incision should be made in the abscess, and also in all cases in which fluctuation can be detected, as well as in those in which the abscess has burst spontaneously, but in which the opening is small. After incising the furuncle it is advisable to press out any core that it may contain and then to syringe the external meatus with a 1: 3000 bichloride of mercury solution, and to direct the patient to instil into the ear a warm saturated boric acid solution frequently during the day.

After the acute symptoms have subsided the patient should be directed to paint the canal with carbolic glycerin (1 : 40), or to instil drops of bichloride of mercury or boric acid solution, in order to prevent the bacteria from advancing further, and this treatment should be continued for some time.

Owing to the debilitated and anæmic condition frequently observed among these patients, particular attention should be paid to the general health. When the furuncle first appears, it is advisable to give the patient several small doses of calomel, to produce a slight laxative effect. The sulphide of calcium, in one-twentieth to one-tenth grain doses, administered every three hours, has seemed to me to have a curative effect in many cases. For chlorotic females large doses of iron should be prescribed, and the diet should be a nourishing one. Cod-liver oil and the syrup of the hypophosphites are also useful. Of late, vaccines have been used in this affection, and the reports have been quite favorable. As the germ is generally staphylococcus (less frequently a combination of staphylococcus and streptococcus) stock vaccines have been used, but it is generally conceded that autogenous vaccines are preferable. The initial dose of staphylococcus vaccine is 50,000,000 to 100,000,000, injected into the subcutaneous tissue of the arm under strictly aseptic conditions. The inoculation is repeated at intervals of from three days to a week, depending upon the reaction obtained. The patient is to be carefully watched and the dose graduated to suit the case.

In streptococcus cases the dose is from 5,000,000 to 10,000,000. After the disappearance of the furuncle the patient will often complain of considerable irritation and itching about the external meatus. To relieve this, ointments containing boric acid or white precipitate of mercury should be applied very lightly to the canal.

OTITIS EXTERNA HÆMORRHAGICA — HEMORRHAGIC INFLAMMATION OF THE EXTERNAL AUDITORY CANAL.

There seems to be a difference of opinion among otologists as to the significance of hemorrhagic vesicles on the walls of the bony auditory canal. The majority of writers, if they mention the occurrence of these vesicles at all, attach no particular importance to them, considering them for the most part as evidence of middle-ear inflammation. That these vesicles are found in the canal in cases of severe inflammation, no one will deny who has had much experience in the treatment of aural cases. I have likewise seen several cases, which I have reported,[1] in which such effusions of blood occurred independently of any middle-ear inflammation, and to my mind constituted a hemorrhagic inflammation of the auditory canal. At first there are usually some pain, slight deafness, and tinnitus. On examination there will be found one or more elongated swellings in the bony canal, usually on its inferior wall, and extending to the drumhead on one side and to the cartilaginous meatus on the other. At times a vesicle is seen on the membrana tympani. The vesicle is due to inflammation of the cutis, the dermal layer being raised by the sanguineous fluid. The vesicles are soft when touched with a probe, and are easily punctured. The inflammation, as a rule, reaches its height on the third day, and the duration of the disease is from eight to fourteen days. The walls of the canal become covered with fine white scales. The treatment consists in puncturing the vesicles, evacuating their contents, and, after drying the canal with absorbent cotton on a probe, insufflating powdered boric acid.

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[1] Archives of Otology, 1890, vol. xix, No. 1.

OTITIS EXTERNA CROUPOSA—CROUPOUS INFLAMMATION OF THE EXTERNAL AUDITORY CANAL.

This is a rare disease, in which the meatus and drumhead are covered by a layer of lymph similar to that found in croup occurring in the larynx. It is generally observed as secondary to otitis media or furunculosis of the canal. The exudate is made up of a fine network containing round cells, nuclei, and epithelium.

Prognosis. The prognosis is favorable. The false membrane should be removed by syringing and forceps, and boric acid powder should afterward be blown into the meatus.

OTITIS EXTERNA DIPHTHERITICA—DIPHTHERITIC INFLAMMATION OF THE EXTERNAL AUDITORY CANAL.

Diphtheritic inflammation of the external auditory canal is associated most frequently with diphtheria of the nasopharynx and middle ear, especially in cases of scarlet fever. Primary diphtheria of the meatus has been described by some writers as developing during an epidemic of that disease in a canal previously excoriated from diffuse inflammation. The exudation, of a dirty gray color, when removed leaves an excoriated and bleeding surface.

Prognosis. The prognosis of diphtheria of the canal alone is apt to be favorable, but diphtheria of the middle ear may lead to serious complications, such as necrosis and loss of ossicles, necrosis of the tympanum and external bony meatus. Great deafness from secondary involvement of the labyrinth may ensue. The glands at the angle of the jaw are frequently enlarged.

Treatment. Besides constitutional treatment, including the use of antitoxin, the ear should be frequently syringed with a bichloride of mercury solution (1 : 3000), and all scales, etc., removed with forceps. Afterward a powder consisting of equal parts of iodoform and boric acid should be insufflated.

SYPHILIS OF THE EXTERNAL AUDITORY CANAL.

Syphilitic affections of the canal are generally confined to condylomata, ulcerations, and at times gummata. Condylomata appear like granulations, but are differentiated from them by the existence of syphilitic manifestations on other parts of the body.

Gummata are seldom confined to the external meatus, but attack simultaneously the middle ear. A gumma may lead to deep ulceration and destruction of the concha. Syphilitic nodules make their appearance at times in the meatus and on the drum-head, and may develop into ulcers. If the patient is improperly treated, the deep ulceration may lead to stricture of the canal. Besides constitutional treatment, such as the administration of mercury and iodide of potash, or of salvarsan, the ear should be syringed with a bichloride solution (1:3000), and all secretion and scales carefully removed. The lotio nigra, or iodoform powder, should be used. In some cases it will be necessary to cauterize the gummata, if very large, with chromic acid fused on the end of a probe.

OTOMYCOSIS—PARASITIC INFLAMMATION OF THE EXTERNAL AUDITORY CANAL.

This is a name given to a parasitic inflammation of the external auditory canal. Aspergillus niger, or nigricans (see Fig. 66), is the fungus most commonly observed, although there are other varieties, viz., the Aspergillus flavus and Aspergillus fumigatus.

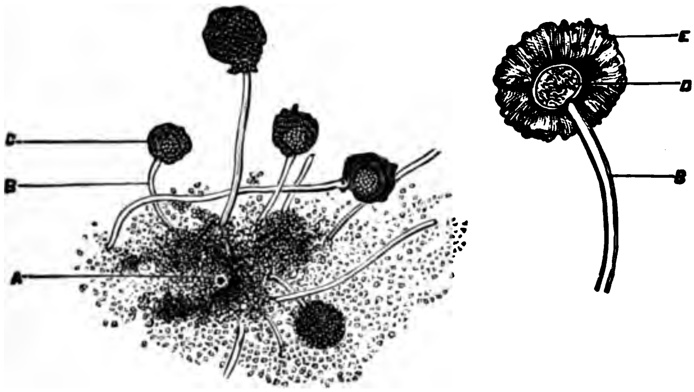
Etiology. The disease is said to be frequent among the Russians, who live in poorly ventilated and damp houses, dampness being favorable to the growth of the fungus. According to some writers, an abnormal secretion in the meatus due to eczema, or a slight discharge in chronic purulent otitis media, favors the growth of the fungus, while others believe the fungous growths are developed after the instillation of oily solutions. Very frequently the cause of the disease cannot be ascertained.

Otomycosis is observed rarely in children or aged persons, but more frequently among the middle-aged, while the poor are more often affected than those in better circumstances.

Symptoms. When the superficial layers alone are affected there are but few symptoms; but later, when inflammation occurs, the patient complains of itching and pain, which may be quite sharp in some instances. There are usually some tinnitus and deafness.

Appearances of the External Meatus. The canal, especially the bony portion, will be covered with loose scales, which, in the case of Aspergillus niger and fumigatus, are studded with blackish spots. In cases of Aspergillus flavus the epithelial scales are covered with mycelium, which appears like a yellowish powder. After removing the epithelial scales the canal and drumhead are usually found red and swollen. The appearances of the disease are quite characteristic when observed through the speculum; but in order to be sure of a diagnosis a microscopic examination is necessary.

FIG. 66.



Aspergillus nigricans. (POLITZER.)

A. Mycelium covered with numerous fallen spores. B. Hypha. C. Sporangium with ripe spores. B'. Hypha. D. Receptaculum. E. Sterigmata with spores.

Besides the epithelial scales and network of mycelium, one observes under the microscope cylindrical filaments or fruit-stalks, which are supplied with septa or hyphæ, and which support the fruit capsule or head of the fungus.

Prognosis. The prognosis is favorable when the case is properly treated, but if neglected the disease may continue for a long time, with many relapses, until the fungus becomes exhausted.

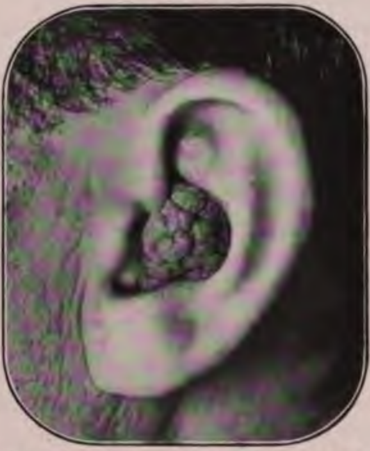
Treatment. After removal of all scales, etc., from the canal, the ear should be filled with a solution of bichloride of mercury in alcohol (1 : 3000). Absolute alcohol should be used if it does not cause too much burning, and should always be instilled warm. Otherwise water should be added to the alcohol. This treatment should be carried out two or three times a day for several days, and occasionally after this for several weeks, in order to be certain of destroying the fungus. Other solutions which are recommended are 2 per cent. alcoholic solution of boric acid or salicylic acid. Some surgeons prefer boric acid powder instead of an alcoholic solution. Bar of Nice believes that in order to cure the disease, one must render alkaline and antiseptic the locality itself. With this object in view, he uses a 4 per cent. solution of bicarbonate of soda and a 1 per cent. solution of corrosive sublimate.

POLYPI.

Granulations and polypi are found at times in the external auditory meatus, as a result usually of furuncles or of caries or necrosis of the bony walls. For the treatment of such cases, the reader is referred to the chapter on Polypi of the Middle Ear.

A patient, male, aged thirty-five, came to my clinic, who had a papilloma (Fig. 67) which was attached to the lining of the external auditory canal. His general health was good, and he said that this growth had been in his ear for four years, and before this time he had not had any ear trouble. It was easily removed, and the patient was discharged cured.

FIG. 67.



Papilloma of the external auditory canal.

ECZEMA, ACUTE AND CHRONIC.

Eczema of the auricle has already been described, and the reader is referred to that chapter for treatment of the disease affecting the external meatus. Reference has also been made in the same chapter to herpes zoster, lupus, and other skin affections involving the auricle.

In herpes zoster the vesicles may be found not only on the posterior surface of the auricle, and especially the lobule and the parts in front of the tragus, but also on the anterior superior wall of the external meatus. Vesicles have also been found on the membrana tympani.

SEBORRHŒA.

A seborrhœal condition of the auditory canal is observed at times, when it is apt to be associated with a seborrhœa of the face and scalp. It gives rise to more or less itching, deafness, and tinnitus, especially if the external meatus contains moist scales and seborrhœal fluid. After the scales have been removed, the best results will be obtained from the insufflation of boric acid, or of boric acid and zinc oxide powder. In some cases ointments containing ammoniated mercury, or the red or yellow oxide, are to be preferred, while especial attention should be paid to the patient's general health.

SEBACEOUS TUMORS.

These tumors are found in the external auditory canal, and should be treated in the same manner as those in the auricle.

CERUMEN INSPISSATUM OR INSPISSATED CERUMEN.

Inspissated cerumen is a frequent cause of deafness, and when found in one ear it is very apt to be present in the other one as well, so that it is always wise to examine both canals. Cerumen may remain in the canal for years, and in consequence become as hard as bone. The cause of the accumulation seems to be due, in some instances, to a scaly condition of the walls of the canal, which prevents the cerumen from escaping as it should do. Once it begins to accumulate, a plug is formed rapidly. In other cases there seems to be an overabundant secretion of cerumen, especially in persons affected with acne and seborrhœa of the face. Anything which prevents the cerumen from coming out of the orifice, such as atresia of the canal, constriction from swollen tissues or bony growths, or numerous hairs about the tragus, will act as a cause. Another cause is due to the fact that patients frequently try to cleanse the ear by pouring soap and water into the canal, and then attempt to dry the ear with the end of a towel, thus pushing the mixed cerumen and soap further in.

Symptoms. Cerumen in large quantities may be present in the external meatus for a considerable period without causing any inconvenience, as long as it does not rest against the drumhead, and provided there is a passage for the transmission of the waves of sound to the membrana. When the canal is closed or the plug falls against the membrana tympani, the patient will then complain of a sense of fulness and deafness. Other symptoms are autophony, or a hollow sound to one's voice like "talking into a barrel"; occasionally, giddiness, vertigo, reflex cough and hallucinations of hearing. Epileptic attacks have been caused by the presence of hardened cerumen in the auditory canal. When the plug is very large, it may irritate the walls of the canal and give rise to more or less pain. In aged persons the external meatus becomes flattened, so that the cerumen is more likely to accumulate. If cerumen collects and forms a plug, a similar accumulation is very likely to recur.

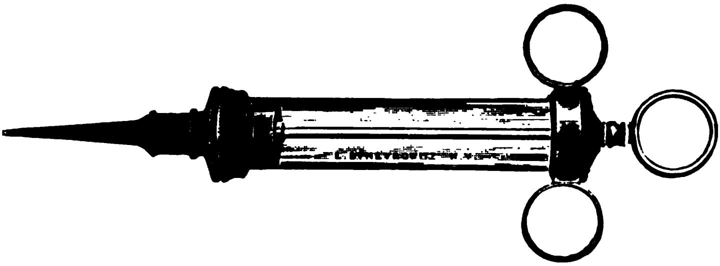
Laminated epithelial plugs, or *keratosis obturans*, may be a cause of deafness in some cases, the plugs being due to a gradual collection and accretion of epithelial laminæ derived from the external auditory canal. They give rise to the same symptoms as inspissated cerumen.

Diagnosis. Frequently a diagnosis can be made with the eye if the auricle is pulled upward and backward. After introducing a speculum, with light reflected from the head-mirror yellowish or brownish masses will be seen, and by touching the same with a probe a diagnosis of cerumen or epithelial plug can usually be made. Sometimes an error in diagnosis is made where there are numerous stiff hairs in the canal covered with cerumen. It is necessary to push the speculum beyond these hairs. Again, the speculum may be directed against a layer of cerumen on the wall of the canal, or a wad of cotton or a foreign body may be smeared over with cerumen and be mistaken for a plug, or the canal may be filled with dry cholesteatomatous masses or dried blood. Tests made with tuning-forks will show increased bone-conduction on the affected side unless the inner ear is affected.

Prognosis. When the deafness has come on suddenly, complete restoration of hearing will usually result after removal of the cerumen. One should be guarded in expressing an opinion, however, before removing the plug, for the case may be complicated by adhesive catarrh or labyrinthine disease.

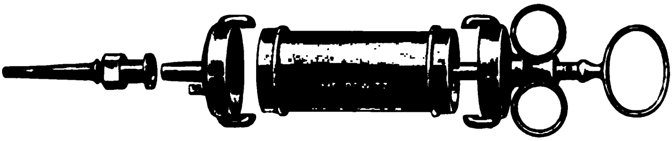
Treatment. When the cerumen or laminated epithelial plug is hard, it should be softened by the instillation of the following: Sodæ bicarb., gr. xxv; glycerin., ʒj; aquæ, ℥j. The drops should be allowed to remain in the canal for fifteen minutes before syringing. Frequently the plug is so hard that it is necessary for the patient to use this solution three or four times a day for several days before the mass can be removed with the syringe. A syringe and warm water (containing in solution a teaspoonful of bicarbonate of soda to the pint) are the best means of removing cerumen. A convenient syringe is the one represented in Fig. 68, which is made of glass, with hard rubber attachments and metallic rings. The hard rubber at each end can be unscrewed and the glass barrel can be kept very clean. The syringe holds about two ounces. The point of the syringe is quite small, to enable the surgeon to direct the stream of water between the wall of the canal and the plug.

FIG. 68.



Author's ear syringe.

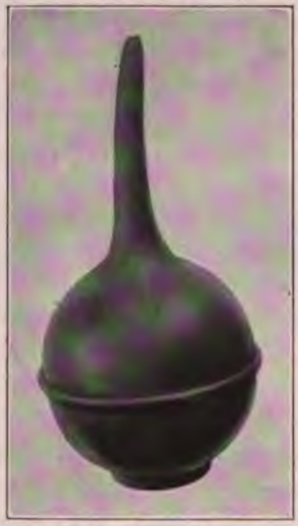
FIG. 69.



Neumann's metal syringe.

Another excellent syringe (Fig. 69), made entirely of metal is easily sterilized, as it can be entirely taken apart. These are not safe syringes to place in the hands of a patient. The soft rubber bulb syringe (Fig. 70) is generally recommended for patients.

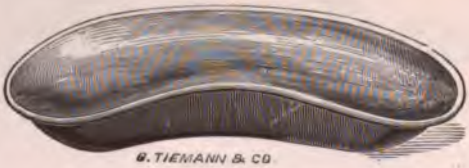
Fig. 70.



Soft rubber bulb syringe.

Before using the syringe, the surgeon should be sure of good illumination, and should direct the stream of

Fig. 71.


G. TIEMANN & CO.

Pus basin.

water between the plug and the canal at different points, in order to have the return current force the obstruction outward. The ordinary pus basin (see Fig. 71), held against the neck and just below the auricle, makes an excellent basin with which to catch the return flow from the meatus. A graduated glass vessel, containing a solution of bicarbonate of soda, should be used for holding the clean water, and under no circumstances should the same vessel be used for both purposes. Very little force should be employed in syringing the ear, for fear not only of doing damage to the drumhead, but also on account of the danger of causing vertigo or faintness in the patient. The surgeon should also inspect the ear from time to time, and frequently it will be necessary to remove the plug with curette forceps (Fig. 36) or with blunt curettes, of which there are three sizes (Fig. 39). The syringe should always be used, if possible, and only in skilled hands and under good illumination from a head-mirror should curettes or other instruments be employed. After the cerumen has been removed the canal should be dried carefully with absorbent cotton on a cotton-holder, made of aluminium (Fig. 38), with a roughened end, and afterward the ear should be inflated by Politzer's method, as the drumhead will usually be found more or less retracted. Then a piece of absorbent cotton should be inserted in the meatus and worn for the rest of the day. In some cases the walls of the canal may be found excoriated, and in such it will be necessary, after drying the canal, to insufflate powdered boric acid and zinc oxide (equal parts). When the plug consists for the most part of layers of epithelium, frequent syringing will often be insufficient, so that it will be necessary to use forceps.

FOREIGN BODIES.

Foreign bodies found in the external meatus are of every shape and variety. There are:

1. Those that are animate—consisting of various insects, viz., fleas, bed-bugs, cockroaches, etc.
2. Those that are inanimate, such as wads of cotton, pieces of paper, ends of slate-pencils, fruit-kernels, beads, cherry-stones, etc.
3. Those that are liable to swell and thus become enlarged, as beans, onions, kernels of wheat, etc.

Foreign bodies that do not swell and which do not cause irritation or inflammation of the canal may remain *in situ* for many years without causing any discomfort. Children are much more apt to put foreign bodies in their ears than adults.

Symptoms. There is usually more or less disturbance of hearing to almost complete deafness, depending on the size, shape, and position of the foreign body. There may be a sensation of pressure or tension and subjective noises, accompanied by more or less pain, according to the irritation and inflammation of the canal, drum membrane, or middle ear. The most serious symptoms often arise from unskilful attempts at removal of foreign bodies, when the auditory canal is lacerated and the drumhead is injured, and severe inflammation results. There may be certain reflex phenomena, such as pain in the head, vertigo, dizziness, vomiting, and coughing. In one case reported, a persistent cough with vomiting was caused by the pressure of two beans in the auditory canal, while in rare instances attacks of epilepsy have been reported as cured after the removal of foreign bodies.

A boy,[1] eight years old, came to the New York Eye and Ear Infirmary with the history of having gotten a bean in the left ear during the morning. He was seen by four physicians, who attempted to remove it, but instead pushed it beyond the isthmus against the drumhead. I found it necessary, under an anæsthetic, to make an incision behind the auricle close to its insertion and to displace the auricle forward, as it was impossible to remove it otherwise. The posterior lining of the canal wall was pushed forward so that the bean could be removed with instruments. The wound was sutured, and healed by first intention, and a strip of sterile gauze was inserted in the external auditory canal.

Prognosis. The prognosis is usually favorable, except in cases in which attempts on the part of an ignorant person have resulted in serious injury to the canal, drumhead, and middle ear; or in which the foreign body has become wedged in the deeper parts of the canal or middle ear, and severe inflammation has followed; or in which pus has not found an outlet, and brain complications have developed.

Treatment. In regard to treatment, much depends on the nature of the foreign body, whether impacted or not, the length of time that it has been in the ear, and the amount of irritation and inflammation of the parts. The first and most important step for the surgeon is to examine the ear with a speculum and good illumination, and determine for himself, and not rely on the patient's statement as to the presence of a foreign body in the ear, for I have seen serious harm done when this precaution had been neglected and instruments had been unskilfully used. When this unfortunate accident has happened, it will be necessary at first to reduce the inflammation before attempting the extraction of the foreign body. When, however, there is but little, if any, swelling or inflammation of the canal, and the foreign substance is not wedged in, the syringe and warm water are usually all that are necessary to remove the foreign body. The auricle should be drawn backward and upward, while the stream of water is directed between the foreign body and the wall of the canal, and it is well at the same time to incline the patient's head toward the affected side. Some writers advise that the patient be placed in the recumbent position, so that the head will hang somewhat over the end of the table, and in this way the upper posterior wall of the auditory canal will be below the membrana tympani, and thus form with it an inclined plane.

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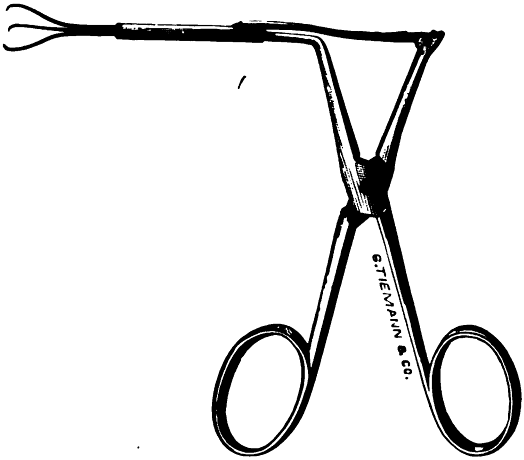
[1] New York Medical Record, Nov 25, 1911.

In the case of foreign bodies likely to swell, oil or glycerin should be poured into the canal, and the ear should then be syringed, or after syringing with water enlargement of the foreign body can be prevented by immediately pouring alcohol into the ear. When the drumhead is perforated or the foreign body has been forced into the middle ear, some writers advise inflation of the ear to assist in the removal of the object. When an insect has gotten into the ear, it is best to kill it first by instillations of oil, when it can usually be removed by syringing or by means of forceps. Occasionally a very small insect will enter the ear and give great annoyance to the patient, while it may escape the observation of the surgeon. In such cases it is always well to syringe the ear.

When the patient comes for advice, and on examination it is found that the canal has been lacerated by attempts made at extraction, and especially if the foreign body cannot be seen, it is always best to allay the inflammation, if possible, before proceeding to any operation. If serious symptoms develop, such as severe pain and meningeal irritation, the surgeon must decide as to the propriety of an immediate operation. In such cases, where the syringe has failed, it will be necessary to resort to instruments, of which all sizes and shapes have been devised, viz., forceps, blunt and sharp hooks, curettes, loops of wire, scoops, etc. No one instrument is suitable for all cases. It is necessary at times to anæsthetize the patient before resorting to the use of instruments, especially when the body has become wedged in the deeper portions of the canal, and in the

FIG. 72.



Allen's foreign-body forceps.

case of small children. The forceps shown in Fig. 37 and Fig. 72 are excellent ones. In using them, however, great care should be exercised not to push the foreign body farther inward, if it cannot be grasped at once. A bent probe or a curette can frequently be passed around the foreign substance.

When the membrana tympani is perforated, injections of warm water through the Eustachian tube by means of the catheter will sometimes dislodge a deeply impacted foreign body. The galvano-cautery has at times been used to divide a foreign body piecemeal, which had become wedged in, before attempting to remove it. Occasionally it becomes necessary to detach the auricle and posterior wall of the cartilaginous canal by making an incision behind the pinna close to the canal, when the foreign body has become impacted in the bony auditory canal or has been forced into the middle ear. The tissues should be divided down to the bone and the periosteum separated, so that the auricle and cartilaginous canal can be displaced forward. This procedure allows the surgeon much more space for the use of instruments.

Nothing but the syringe and warm water should ever be used by the surgeon, in the case of a foreign body in the ear, unless he understand thoroughly the use of the speculum and head-mirror and has had considerable experience in the treatment of aural patients.

INGROWING HAIRS.

Hairs from the auditory meatus at times are so thick and long that they may interfere with the hearing, or they may even rest against the drumhead, giving rise to noises in the ear, especially when the patient moves his jaw. Epilation is required in extreme cases.

HEMORRHAGE FROM THE EAR.

Hemorrhage from the ear, beside being due to direct injuries from foreign bodies, or to the presence of granulations and polypi, may be caused by fracture of the bony canal following a blow on the jaw. Bleeding from the ear, or vicarious menstruation, sometimes occurs in females during the menstrual period.

EAR-COUGH.

This phenomenon is noticed frequently in patients when examination is made of the ear by the introduction of a speculum. Foreign bodies and impacted cerumen in the external meatus have been known to cause severe attacks of coughing. The explanation is that the cough, reflex in character, is due to irritation of the auricular branch of the pneumogastric (which latter supplies the auditory canal).

ADHESIONS AND CONTRACTIONS OF THE MEATUS —EXOSTOSIS.

Swelling and infiltration of the lining membrane of the external meatus may occur during the course of chronic suppurative otitis media, and in some cases of inflammation of the external auditory canal, and thus lead to contraction of the external meatus. During the course of long-standing suppuration from the middle ear in cases due to diphtheria or syphilis, or to injuries of the canal from instruments or chemicals, cicatricial strictures may result, and give rise to alarming cerebral symptoms, if operative procedures are not immediately undertaken, so that pent-up secretions may escape. When the contraction is due simply to hypertrophy of the tissues from inflammatory infiltration, much may be accomplished by treatment. Attention should first be directed to the cure of the chronic otorrhœa if present, while the infiltration of the tissues will often subside under the use of ointments containing mercury. In the case of strictures, some are circular while others are annular in shape, and the opening, being as small as a pin's head, may be mistaken by the inexperienced observer for a perforation in the drumhead. The contraction may in other cases extend from the bony canal to the external orifice of the meatus. Bony strictures also are observed, which are due to periosteal ossification of the walls of the external meatus or to *hyperostoses*. The latter are found generally on the anterior and posterior walls of the external auditory bony canal. They are more frequent among "the rich than the poor" and in certain families there is undoubtedly a predisposition. Fracture of the temporal bone, involving the bony canal may also be an exciting cause. Osseous strictures are associated often with caries and necrosis of the temporal bone, and develop after sequestra have been removed. The deafness in these cases will depend altogether on the condition of the middle ear, and also on the amount of secretion or epithelial scales that is retained behind the stricture. In making a diagnosis of stricture, a careful examination should be made with the probe, to ascertain whether the stricture is due to membrane or to bone.

Treatment. The most important point in the treatment should be the cure of any otorrhœa or inflammation of the external auditory canal. If the inflammatory hypertrophy does not diminish under such treatment, the contracted parts may be dilated by inserting plugs of absorbent cotton soaked in a carbolic acid or boric acid solution, especial care being taken not to leave them in too long at a time, as secretions are apt to be retained behind them. An annular stricture should be excised and the canal further dilated by the use of cotton plugs or the insertion of sponge-tents. If these means fail, laminaria tents are sometimes employed, but, as a rule, they are too painful. I have in some cases inserted rubber tubing, through which a quill toothpick had been passed, the idea being to prevent collapse of the rubber tube, and thus allow the pus to escape, and at the same time to exert continuous pressure against the walls of the external meatus. In all cases in which there is suppuration, as in chronic otorrhœa, the pus should be removed carefully by syringing with a bichloride of mercury or boric acid solution before inserting the tube. Hard-rubber and silver tubes are used also for the same purpose. When the stricture is osseous, very little can be accomplished in the way of dilating the canal except by operation. The latter should never be undertaken unless pus or some other secretion is prevented from escaping, or there is extensive caries or necrosis. In such cases the auricle should be displaced forward and the lining of the posterior wall of the canal dissected away, to give a good view of the seat of the operation.

Beside *hyperostoses*, already mentioned, *exostoses* are found in the canal. These are new formations of bone.

Their structure may be very dense like ivory, or spongy, or even hollow; they may have very broad bases or be pedunculated; and they may exist singly in one or both ears, or may be multiple. I have seen cases in which there were many white nodules situated on the walls of the external auditory canal and close to Shrapnell's membrane. Those that are spherical in shape are usually found on the upper posterior wall of the external bony canal. They may remain moderately small or grow to such a size as to close the lumen of the canal. Koerner found in one hundred and forty-seven cases of exostosis or hyperostosis of the external auditory canal that one hundred and fourteen were men and only thirty-three women. Also that people living by the sea were more frequently affected than those in inland countries, and that the disease was more frequent in England than on the continent. There is also an undoubted inherited tendency to the disease in certain families. Exostoses may be due to chronic periosteal inflammation of the bony canal as a result of fracture, or may result from chronic suppurative otitis media. Polypi and new cartilaginous growths occasionally ossify. Syphilis, gout, and rheumatism are mentioned as causes of these bony tumors, but, according to my experience, sea-bathing plays a much more important rôle.

Diagnosis. By means of the probe the diagnosis can usually be made, as the tumor will be found hard and resisting, and frequently very tender to the touch.

Treatment. When the exostoses are small and do not interfere with the hearing-power, and do not prevent the escape of cerumen and other secretion, no operative measures are usually required. A small pedunculated growth can sometimes be removed through the auditory canal with a small chisel, but as a rule it is much wiser to displace the auricle forward by making an incision behind the pinna down to the bone, especially when the exostosis has a broad base and is of compact tissue. The periosteum should be pushed forward so that the external auditory canal is exposed and the exostosis reached in this way. A chisel or gouge and mallet should be used or the dental burr (Fig. 155) which is rotated by a motor. The most thorough aseptic precautions should be followed and all instruments thoroughly sterilized. After the exostosis has been removed, the hemorrhage should first be controlled, and then the auditory canal should be gently packed with a strip of sterile gauze, the wound behind the auricle having been closed by sutures or the Michel clamp (Fig. 91). Sterile gauze pads should then be applied over which a layer of absorbent cotton is placed, and the dressings held in position by a bandage.

The use of mercury and iodide of potash is indicated in all cases in which there is a history of syphilis. Some surgeons recommend painting the exostosis with tincture of iodine, but such treatment is of little if any avail, while there is great danger of causing a severe inflammation of the external auditory canal from its application.

CHAPTER V.

DISEASES AND INJURIES OF THE DRUMHEAD AND MIDDLE EAR.

MYRINGITIS, ACUTE AND CHRONIC.

MANY otologists do not believe that inflammation of the membrana tympani (myringitis) ever occurs without simultaneous involvement of the middle ear. In the acute stage the drumhead will be found congested in part only or in its whole extent. In the later stage there is apt to be an effusion of serum in the dermal layer, as well as slight effusions of blood, while small vesicles, filled with serum, often develop. As a rule, the dermal layer alone is involved; but in severe inflammation abscesses sometimes form in the deeper layers of the drumhead, when it becomes much more difficult to distinguish this form of inflammation from acute otitis media.

Symptoms. Pain, usually moderate in character, is complained of, although it may be sharp and stinging in severe cases. Other symptoms are a pulsating noise and more or less tinnitus. The disturbance in hearing is usually much less than in cases of acute otitis media, and one is justified in making a diagnosis of acute myringitis when, in spite of more or less swelling or bulging of the membrane, the hearing-distance is not materially affected. Frequently, however, the two diseases are associated, or a case beginning as an inflammation of the drumhead is followed by acute otitis media, so that in many instances it becomes difficult to separate the two. The duration of the disease is usually four or five days. After the vesicles have burst, the membrana assumes a macerated appearance and the dermal layer peels off, leaving a congested drumhead. In the chronic form there is more or less suppuration, with the formation of granulations or ulcerations on the drumhead if the disease has run a protracted course.

Treatment. In severe cases the artificial leech should be applied, while in the mild form of this inflammation the vesicles generally burst and recovery follows in a few days. The insufflation of boric acid powder is indicated in the latter cases. In the chronic form boric acid alone or combined with zinc oxide (equal parts) should be insufflated, or drops should be instilled, containing zinc sulphate, copper sulphate, or lead acetate, in the proportion of four grains to the ounce, or alcohol drops containing fifteen grains of boric acid to the ounce of alcohol. Granulations should be cauterized with nitrate of silver fused on the end of a probe.

INJURIES OF THE MEMBRANA TYMPANI.

Injuries of the drumhead are usually caused (1) by the introduction of a foreign body, (2) by a blow or explosion producing a sudden condensation of air in the external meatus or tympanum, or (3) by a fracture of the cranial bones, thus involving the drumhead.

Diving, sea-bathing, boxing the ears, the discharge of cannon, and gunshot wounds are frequent causes of rupture; also violent paroxysms of coughing, vomiting, and sneezing. Again, ruptures are often met with in patients who have tried to remove wax from the ears with toothpicks and hair-pins, and have pushed them in too far, so that these and other unskilful attempts at the removal of foreign bodies often cause serious trouble. Rupture of the drumhead has been known to follow a too violent inflation of the ear by Politzer's method, and also the sudden exhaustion of the air from the external meatus by the use of Siegle's otoscope. In the cases where rupture occurs from the sudden condensation or rarefaction of air, it will generally be found on examination that catarrhal changes have taken place in the membrana tympani, and that there is more or less obstruction to the entrance of air through the Eustachian tube.

In direct injuries the point of rupture is most frequently observed in the anterior half of the drumhead, and the size and shape of the rupture or perforation depend to a great extent on the nature of the instrument used. A sharp-pointed instrument is apt to cause a wound somewhat round (see Plate I., Fig. B), the edges being covered with dark-red blood, and frequently there is more or less blood in the canal, with laceration of the meatus. Inflammation of the middle ear, followed by suppuration, may result from direct injuries. The shape of the rupture produced by indirect violence is, as a rule, gaping, so that the inner wall of the tympanum will be seen. (See Plate I., Fig. C.) This wall will appear reddish yellow in color, in direct contrast to the bright-red hue observed in cases of acute or chronic otitis media. The most frequent seat of the rupture is in the posterior half of the membrana, and the shape of the perforation is usually round or oval, with the long axis of the oval running parallel with the direction of the radiating fibres. There is, as a general rule, but one rupture. When the rupture is due to a fall or blow, there may occur at the same time concussion of the labyrinth, with marked deafness, and it is in such cases, as well as in those in which suppurative inflammation of the middle ear has developed, that permanent disturbances of hearing frequently remain after the perforation has healed.

Beside the causes already mentioned, the author has reported a case[1] of injury to the membrana tympani from a twig. The patient was walking through the woods when a twig of a branch penetrated the right auditory canal, rupturing the drumhead. In another patient the injury to the ear was due to a pistol-shot wound. The most serious cases are those in which there is concussion of the labyrinth from a fall or blow. The prognosis in such instances must always be grave, and on account of their medico-legal significance they become of great interest to the aural surgeon, who is frequently asked to give expert testimony as to the diagnosis and prognosis of such accidents. In order that the surgeon may express an opinion as to whether the rupture is of traumatic origin, it is absolutely essential that the drumhead be inspected immediately after the alleged injury. Just after an injury to the drumhead from a sharp-pointed instrument, as previously mentioned, the edges will be covered with dark-red coagulated blood; and if the rupture is large, the middle-ear wall will appear yellowish red. If suppuration has already occurred, it is impossible to make a diagnosis of traumatic rupture.

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[1] Bacon: Transactions of American Otological Society, 1888.

Usually when the perforation has been due to disease of the middle ear, even when of large size, a sharp, hissing sound is heard when air is forced through the Eustachian tube by the Valsalvian or Politzer method; while in a normal ear which has been ruptured through traumatism, the escaping air causes a broad, deep-breathing sound. Injuries to the drumhead from sharp instruments heal rapidly, as a rule, if inflammation of the middle ear does not follow.

If suppurative inflammation occurs, the disease may become chronic and lead to complications, or the drumhead may be thickened and adhesions take place, or there may be concussion of the labyrinth with or without rupture of the drumhead. In all such cases permanent disturbances of hearing may remain. In cases in which deafness results from a blow or fall, and the drumhead and external meatus appear normal, while there is loss of bone-conduction, as shown by the tuning-fork, the surgeon should be very guarded in expressing an opinion as to the cause of the deafness, for in such instances much depends on the answers given by the patient, who may be a malingerer. Tuning-fork tests show that the bone-conduction is much diminished or even lost in labyrinthine disease. while the patient is apt to complain of subjective noises, giddiness, deafness, and a dull feeling in the head.

An interesting case[1], under my care, was that of a young woman who was struck on the right mastoid process with a tennis racket, and a week later the ear began to discharge. The pain was severe in the ear and in the mastoid region ever since the accident. When I first saw her, there was a distinct fluctuation in the soft tissues over the mastoid process. On operating, I found a sinus leading to the mastoid cells, the latter being filled with pus and softened bone. The patient made a good recovery.

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[1] Medical Record, November 25, 1911.

Another case was that of a man, thirty-eight years of age, who suffered from labyrinthine deafness in one ear, due to a boiler explosion. At the time five men standing near the boiler were killed, but this patient happened by chance to be at the other end of the room and so escaped more serious injury. The ear exposed to the boiler was affected. He was also troubled with vertigo and distressing tinnitus.

Still another case was that of a boy, who was brought to me with the history that ten days ago he had fallen from a railing 10 feet high, striking the left side of his head against the concrete. He was unconscious for twelve hours and bled profusely from the left side of the nose, and he vomited for two days. There was no dizziness nor staggering gait. The drumheads were intact, and the profound deafness was due to an affection of each labyrinth.

A case[1] has been reported in which a suit was brought for damages on account of an alleged blow on the ear. In this instance the boy was a catarrhal subject, and the hearing was as much affected on one side as on the other.

Got[2] has published his observations with regard to injuries of the hearing apparatus as a result of the war in Europe. Of 32 cases he describes two groups: one in which the injury was due to explosions with the air as an intermediary, and the other due to direct injury to the head. Hemorrhage seemed to be the cause of the ear symptoms.

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[1] Bacon: New York Medical Journal, December 12, 1888.

[2] Rev. de Laryngol., d'Otol. et de Rhin., January, 1916.

There was fairly rapid improvement in most of the cases, even as to the hearing, but those of psychic origin were the only ones completely cured. Where vestibular symptoms were present the nystagmus and vertigo were the first to show improvement. The sense of equilibrium gradually became normal, and the affections of the cochlear nerve were the last to respond.

In a more recent study the same writer found that in most of the cases the injury to the labyrinth was due to the bursting of the shell at a distance of from two to five meters from the patient. At a greater distance than this the ear resists the effects of the concussion, or the affection is a slight one.

Lermoyez[1] has expressed the opinion that from his observations patients with normal ears are more likely to have the labyrinth involved than those whose ears are defective.

Treatment. It is most important that the instillation of drops and syringing the ear should carefully be avoided in all cases of simple rupture. The patient should be kept quiet and placed on a low diet for a few days, and a piece of absorbent cotton should be inserted in the meatus. When inflammation of the membrana occurs, the artificial leech should be applied in front of the tragus (see Treatment of Acute Otitis Media); if suppuration ensues, the same treatment should be followed as that indicated for acute suppurative otitis media. When concussion of the labyrinth has occurred, permanent disturbance of hearing and tinnitus will occasionally remain in spite of all treatment. In some cases, nerve tonics containing strychnine sulphate are indicated. Others improve under the administration of iodide of potash and hypodermic injections of pilocarpine. The constant electric current is beneficial in other instances.

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[1] Presse méd., February 25, 1915.

A rare form of injury to the drumhead is *fracture of the handle of the malleus.* The lesion may be due to a fall or to a direct injury to the membrana tympani. It is possible to make a diagnosis of this condition if the surgeon can discover a false point of motion in the long handle while the patient inflates the ear by the Valsalvian method.

OTITIS MEDIA ACUTA, OR ACUTE INFLAMMATION OF THE MIDDLE EAR.

Acute inflammation of the middle ear may be either catarrhal or purulent. Very frequently, however, one disease runs into the other, so that it is extremely difficult in some cases to make any distinction.

OTITIS MEDIA CATARRHALIS ACUTA, OR ACUTE CATARRHAL INFLAMMATION OF THE MIDDLE EAR.

There are in the first stage considerable hyperæmia and swelling of the lining membrane of the tympanic cavity and of that covering the ossicles and inner surface of the drumhead. There is probably a more or less hyperæmic condition of the lining membrane of the mastoid cells in many, if not all, cases of this disease. After the acute stage there follows more or less effusion of serum containing exudation cells. In severe cases there may be ecchymoses. The epithelium lining the tympanum peels off and becomes macerated. Thick mucus, pus-cells, and numerous red blood-corpuscles are found in the tympanic cavity. In some instances the mucus is very tenacious and stringy, while in others there is a preponderance of pus-cells. This affection is what is commonly called "earache" in children, and some children are especially liable to frequent attacks. It is more often observed during the spring and winter months, when sudden changes in temperature are apt to occur.

Causation. This disease most frequently follows a pharyngitis or "cold in the head," or it may be due to long exposure to wet or cold; or it may be a complication of the acute infectious diseases, such as measles, scarlatina, whooping-cough or pneumonia, bronchitis, tuberculosis, puerperal fever, cerebrospinal meningitis and syphilis. Another cause is the use of the nasal douche, by means of which water entering the Eustachean tube sets up an acute inflammation. In many instances the same accident follows the pernicious practice of "sniffing up" salt and water for the relief of nasal catarrh.

Teething children are liable to attacks of catarrhal otitis media, which frequently develops into the purulent form with perforation of the drumhead.

Sea-bathing is one of the causes of this disease as well as nasopharyngeal catarrh, or it may be due to the presence of adenoid growths and enlarged tonsils. In sea-bathing there is a liability that water filling the external meatus may cause an inflammation of the canal or middle ear, while, on the other hand, an acute otitis media may result from water entering the middle ear through the Eustachian tube. Parents should forbid children to "duck" the head or to dive while bathing, and should always insist that they wear in the ear a piece of non-absorbent cotton-wool. A small piece of wool should be smeared with vaseline and then pushed well into the auditory canal so that it cannot be washed out.

Symptoms. There is a dull feeling or fulness about the ear, or the pain may be sharp and stinging in character and quite severe at night. Infants are liable to scream and to put the hand to the side of the head. Headache is sometimes complained of. The pain frequently radiates about the ear and side of the head, and shoots toward the teeth, and the patient may complain of pain on opening the mouth and when pressure is made just below the lobule. In children, more especially, this form of disease is accompanied by fever, while in rare instances delirium and convulsions are observed. In infants meningitis is sometimes suspected until an examination of the ear reveals the cause of the disease. The pain, though much less severe in acute catarrhal than in acute purulent otitis media, is due to the severity of the inflammation itself, to the pressure exerted on the drumhead by the exudation, or to great retraction of the drumhead.

Constriction of the Eustachian tube interferes with the proper ventilation of the tympanic cavity; owing to absorption of the air in the tympanum having taken place, the drumhead becomes retracted from the atmospheric pressure and the patient complains of pain and deafness.

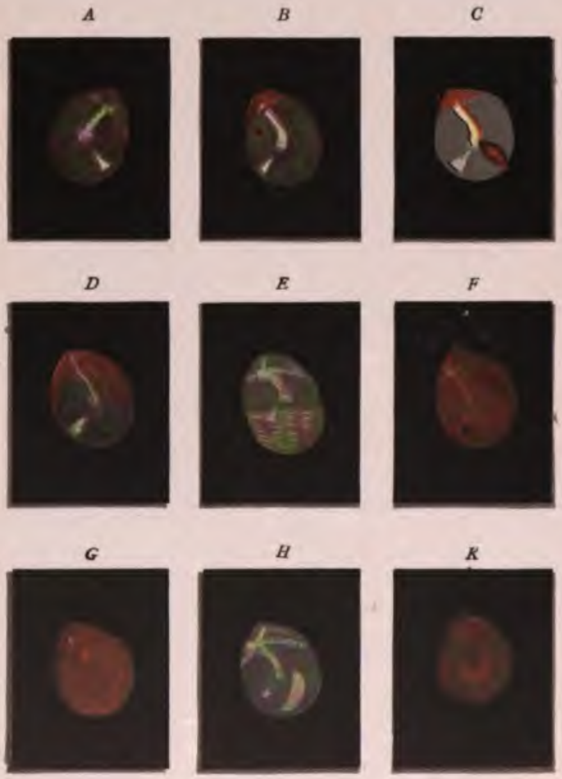
In the milder cases the pain is of short duration, but in the more severe ones it is apt to continue for several days, while during convalescence the patient has a feeling of fulness and pressure in the ear.

Tinnitus, or noise in the ear, of a hissing, rushing, singing, or pulsating character, is a source of considerable annoyance to the patient. The deafness in the early stage as well as the tinnitus is due to the intense hyperæmia and to inflammatory exudation. The disturbance in hearing is apt to be more marked during the stage of exudation, but the degree of deafness does not depend so much on the amount as on the seat of the exudation in the middle ear. If both fenestræ in the middle ear are clogged, there is apt to be great deafness. A patient frequently complains of autophony—*i. e.*, a muffled sound of his own voice, which is likened to the hollow sound heard when talking with the head in a barrel. Another source of annoyance is the hearing by the patient of the same note double (diplacusis)—that is, a tuning-fork when vibrating and held close to each ear will seem a tone or half a tone higher, usually on the affected side. This same phenomenon also occurs in labyrinthine disease and in some cases of exostosis.

In children the pain is especially apt to come on during the night, while in the daytime it is not generally so severe. Parents very often attach but little importance to such attacks, and consider that it is not necessary to seek professional advice for a mere earache. Repeated attacks, however, frequently lead to changes in the drumhead and adhesions, and later in life to deafness. There would be far fewer cases of incurable chronic middle-ear catarrh if these children during early life had received proper treatment. The duration of the disease varies from a few days to a week or ten days. There may be several relapses. Much depends on the general condition of the patient and on the causation.

Appearances of the Membrana Tympani. In less severe cases the drumhead appears congested, especially

PLATE I



about Shrapnell's membrane and the long handle of the malleus. (See Plate I., Fig. D.) The bony canal may or may not be involved. In severe cases the whole membrane is of a reddish, angry-looking color, and frequently has a gray appearance on account of the infiltration of the dermal layer. The only landmark, the short process, appears as a red or yellowish-white point. The posterior superior quadrant of the membrane may present a bulging appearance due to inflammatory infiltration. In some cases there may be vesicles and interlamellar abscesses. Bulging and exudation sacs in connection with the tympanic cavity are occasionally observed. In other cases there may be a bulging outward of Shrapnell's membrane or of the posterior inferior quadrant of the membrana vibrans, due to the presence of fluid in the tympanum. The congestion gradually disappears when resolution begins, and the membrana at first assumes a grayish appearance, with small, tortuous vessels running from the periphery

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EXPLANATION OF PLATE I.

A.—Normal membrana tympani. Pages 29, 74, 75.

B.—Injury to drumhead from a sharp-pointed instrument. Congestion in Shrapnell's membrane and along the handle of the malleus. Page 156.

C.—Rupture of drumhead due to indirect violence. Page 156.

D.—Acute catarrhal otitis media. Hyperæmic appearance of the membrana tympani in the early stage. Page 165.

E.—Sero-mucous catarrh of the middle ear. Fluid in tympanum seen through transparent membrana tympani. Page 169.

F.—Acute purulent otitis media. Deeply congested membrana tympani. Perforation in the lower anterior quadrant. Page 176.

G.—Acute catarrhal or purulent otitis media. Stage of resolution. Membrana tympani gradually assuming a grayish appearance. Tortuous vessels extending from the periphery to the handle of the malleus. Pages 166, 179.

H.—Chronic catarrhal otitis media. Great retraction of drumhead, with a chalky deposit, crescentic in shape, in posterior portion. Page 230.

K.—Chronic purulent otitis media. Large perforation. Handle of malleus, resting against the inner tympanic wall. Page 265.

toward the handle of the malleus. (See Plate I., Fig. G.) The epidermis peels off from the membrana and bony canal, while the congestion remains longest along the handle of the malleus and in Shrapnell's membrane.

Treatment. Acute catarrhal otitis media in children is often due to the presence of enlarged tonsils or of adenoids, so that it is of the greatest importance to make a thorough examination of the nasopharynx in all cases. Usually in young subjects it is impossible to obtain a satisfactory view of the nasopharynx with the rhinoscopic mirror, a fact which compels the otologist to make a digital examination of this region. With a rubber band on the index finger, to prevent it from being bitten, an examination can readily be made; or, better still, the method should be adopted as described on p. 199. There are many little patients, however, of a nervous temperament whom it is necessary to anæsthetize even when making an examination. In such cases chloroform or nitrous oxide gas is to be preferred. (For the further treatment of adenoids, the reader is referred to the chapter on Nasopharyngeal Diseases.) In the first or hyperæmic stage of acute catarrhal otitis media the local abstraction of blood by means of the artificial leech is a valuable method of treatment, and if applied early will often cut short the attack and relieve the pain. The leech should be applied in front of the tragus. (See method of application under Treatment of Acute Purulent Otitis Media.) In children warm water gently poured into the ear will often stop the pain, or the ear may be douched with warm water (containing boric acid, ℥j to Oj) every two or three hours. Some surgeons prefer dry heat applied by means of a hot-water bag or a hot bag of salt. In the mild cases the instillation of a saturated boric acid solution will be all that is necessary if careful attention is paid to the condition of the pharynx and nasopharynx, or the instillation of a 10 per cent. solution of opium[1] in sterile oil. A 4 per cent. solution of cocaine in sterile oil is of benefit in some cases.

According to Kirchner, 10–20 per cent. carbolic glycerine warmed and dropped into the ear may in two to three applications cut short the inflammation. When a perforation has occurred this concentrated solution will cause severe pain. The author uses a 5–10 per cent. solution instead of that advocated by Kirchner. To abort the inflammation Kirchner recommends most highly Burow's solution (Liq. alumin-acetat. 12 parts, plumbi acetat. 5 parts, and water 100 parts). The ear should be filled with this solution warmed three to four times a day and it should be allowed to remain in the canal twenty to thirty minutes.

In children when the Eustachian tube is swollen and the drumhead is very much retracted, a condition of affairs resulting from a nasopharyngeal catarrh, (tubal catarrh), the treatment should consist in inflation of the middle ear by Politzer's method or catheterization, and the application of astringent sprays to the nasopharynx.

After the inflammatory stage has passed, the catheter or Politzer's method should be employed, in order to prevent adhesions, to restore the membrana tympani to its normal position, and to remove any mucus or other fluid from the tympanum. If the disease follows a cold, small doses of calomel should be given, to produce slight catharsis, and aconite should be administered in small and frequently repeated doses. The patient should be kept quiet in the house and given a light diet. Gargles are generally indicated, and attention should be paid to the nares as well as to the nasopharynx. It is always best not to administer opium unless absolutely necessary. Patients who frequently have "colds" should be cautioned against taking large doses of quinine, as deafness is undoubtedly caused by this practice in some instances. Catarrhal subjects should be impressed with the importance of paying strict attention to the general health. They should lead an out-of-door life as much as possible, protect their feet in stormy weather, and should sponge the neck and chest every morning with cold water, and follow this by vigorous rubbing with a coarse towel. Living in overheated rooms is a frequent source of catarrhal disease. If there is bulging of the membrane, suggesting the presence of fluid in the tympanic cavity, the drumhead should be incised immediately. (See Treatment for Acute Purulent Otitis Media.)

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[1] A 10 per cent. solution of opium in hydro-carbon oil, which must be filtered and sterilised.

SUBACUTE CATARRHAL OTITIS MEDIA.

This is a form of inflammation similar to acute catarrh, except that it is milder in character, the pain and inflammation being less marked. The patient is usually subject to frequent attacks, while the tonsils are apt to be enlarged, and the disease is liable to become chronic. This disease is often found among school-children, who for-merely were thought to be inattentive. Proper hygienic surroundings, tonics, etc., should be prescribed, and treatment directed to the nares and postnares, in addition to inflation of the middle ear by Politzer's method.

What is commonly called *tubal catarrh* is an inflammation of the Eustachian tube, leading to great retraction of the drumhead. The membrana is usually but slightly congested. As the swelling of the walls of the tube allows but little air to enter the tympanic cavity, the air in the middle ear becomes absorbed and retraction of the membrana follows. This affection is usually secondary to nasopharyngeal catarrh.

Seromucous catarrh, or *hydrops ex vacuo*, is in reality another form of acute catarrhal otitis media. In this affection the faucial end of the Eustachian tube is usually congested and swollen, leading to closure of the tube. Acute inflammation of the nasopharynx is generally the cause of the disease. The drumhead may be slightly congested as well as retracted, and other changes of color will be noticed, depending on the amount of the exudation, the condition of the middle ear, and the transparency of the drumhead. When the tympanic membrane is translucent and there is a seromucous exudation, a line of demarcation between that portion of the tympanum containing air and that containing fluid will be distinctly seen. The latter portion usually appears greenish yellow in color and the former darkish gray. (See Plate I., Fig. E.) When the patient moves his head the line of the fluid will change if it is serum. After inflation of the middle ear, air-bubbles, as rings, will be seen through the membrane if the latter is transparent.

Symptoms. The symptoms generally observed are very slight pain, a sense of fulness or pressure in the ear, tinnitus of an intermittent character, autophony, and a cracking sound in the ear, which latter is probably due to a sudden separation of the walls of the Eustachian tube, and more or less deafness. Tests with the tuning-fork show increased bone-conduction on the affected side unless the labyrinth is involved.

Prognosis. The prognosis is generally favorable when the inflammation is due to a cold and the patient's general health is good. The disease in some instances becomes chronic, and may lead to adhesions and deafness.

Treatment. When there is fluid in the middle ear, it may sometimes be made to disappear by Politzer's method of inflation or by catheterization. A much more satisfactory method, however, is to puncture the drumhead in its posterior inferior quadrant, and then force the fluid out by inflation or by the use of Siegle's otoscope. Careful attention should be paid to the patient's general health, and treatment directed to the nasopharynx, the nasal passages, and the mouth of the Eustachian tube. Catarrhal patients should be advised to follow the same line of treatment as that recommended in the chapter on Acute Catarrhal Otitis Media. Preparations containing iron and strychnine should be given. Whenever possible, catheterization is preferable to Politzer's inflation. In children, however, and in adults of a nervous temperament, and also in all cases in which there is much inflammation and irritation about the faucial end of the Eustachian tube, Politzer's method should be employed. As to the frequency of inflating the ears, a good rule is to inflate the ear at first every day for several days, then every other day, and less frequently as the condition requires. A method advocated by Politzer, of removing the fluid from the tympanum, is as follows: After the patient has taken a little water in his mouth he is directed to turn his head well forward and somewhat toward the opposite side, a position which causes the pharyngeal orifice of the Eustachian tube to point directly downward. The patient should keep his head in this position for a minute or two, in order to allow the secretion to flow toward the orifice. Air is then forced into the middle ear by Politzer's method. In some instances in which the mucus in the middle ear is tough and stringy, it is necessary, in order to remove the secretion, to make a free incision in the drumhead, and then inject into the tympanic cavity a very weak solution of bicarbonate of soda.

CHAPTER VI.

OTITIS MEDIA PURULENTA ACUTA, OR ACUTE PURULENT OTITIS MEDIA.

ACUTE purulent otitis media differs from acute catarrhal otitis media in the greater intensity of the stage of inflammation, and the occurrence of a purulent discharge with perforation of the membrana tympani. In the early stage of the disease there is marked congestion of the tympanic cavity and tympanic end of the Eustachian tube. If the inflammation has extended from the nasopharynx, which is usually the case, the Eustachian tube in its whole extent is more or less congested and swollen. It is probable that the lining membrane of the mastoid cells is likewise congested at the same time in many, if not all, cases of acute purulent otitis media. In some instances there is hyperæmia of the labyrinth with serous exudation. The inflammatory stage is followed by considerable swelling of the lining membrane of the middle ear. The discharge is frequently of a serous character at first, or it may be mucopurulent. Later, however, it becomes decidedly purulent. It may be scanty or very profuse. Acute suppurative otitis media frequently follows the acute catarrhal variety, so that, clinically, the two diseases should be considered as different stages of the same disease, viz., acute otitis media. In cases of tuberculosis there is, as a rule, but little hyperæmia, the mucous membrane of the middle ear appearing of a pale, reddish-yellow color, while the discharge or exudation is apt to be thin and watery.

Occasionally the discharge may be acrid and give rise to severe and extensive excoriation about the canal and pinna in a very short time, sometimes within two or three days but fortunately this does not occur frequently in acute cases, and generally in ill-kept and poorly nourished children.

In cases due to *influenza*—and these constitute by far the greatest number—the discharge is at first serosanguinolent and very sticky in consistency. In some cases there is more or less blood, and the stage of inflammation is marked by great hyperæmia and swelling of the mucous membrane. These symptoms are so constant that they are very characteristic of *influenza otitis*, while the mastoid cells are very often involved at the same time, and in rare instances the labyrinth is affected.

Etiology. Purulent inflammation of the middle ear usually occurs in connection with acute or chronic nasopharyngeal catarrh, and may be due to the same causes that produce acute catarrhal otitis media. Beside the influenza and colds, which are responsible for a great many cases, the exanthematous diseases play a most important rôle in the causation, especially measles and scarlet fever. Other causes are diphtheria, exposure to wet and cold, smallpox, typhus and typhoid fevers, tuberculosis, pneumonia, bronchitis, whooping-cough, syphilis, erysipelas, diabetes, and the puerperal state. Acute suppuration of the middle ear is due at times to operations on the drumhead, such as paracentesis, to blows on the head or ear, or to falls, to the improper use of instruments when attempts are made to extract a foreign body from the external meatus, and to the use of caustic applications, and occasionally it follows operations on the nose. Water occasionally enters the Eustachian tube and middle ear from the nasal douche, and from "sniffing up" salt water and other solutions for the relief of nasal catarrh, a most pernicious practice, which often causes severe inflammation of the middle ear and occasionally of the mastoid cells. This condition of affairs is also brought about frequently by the use of a small glass douche, at present quite popular with the laity, the employment of which requires the patient to throw his head backward in order to wash out the nasal cavity. During dentition there is apt very frequently to be a purulent discharge, and it is most important in such cases to examine frequently the ears during this period. *Sea-bathing* is another cause of this disease. The drumhead may be ruptured in diving or from the force of a wave striking against the side of the head ; or the cold water filling the external meatus may set up an inflammation of the drumhead and later of the middle ear. Frequently, however, I believe that an earache from sea-bathing is due to the fact that water enters the middle ear through the pharynx and Eustachian tube, the result frequently of forcibly blowing the nose after diving, the uniform act of every bather.

Children are more frequently subjects of this disease than adults, and it is observed more often in winter and spring, especially during sudden changes of weather. Children are apt to have both ears affected from scarlatina, measles, or diphtheria.

Borden,[1] in a report of two thousand two hundred and thirty-two cases of scarlet fever, measles, and diphtheria, states that seven hundred and forty-six cases of scarlet fever showed 11 per cent. of aural complications; four hundred and fifty-six cases of measles, 28 per cent., and nine hundred and sixty-two cases of diphtheria, 2.9 per cent. Further, 31 per cent. of the fatal diphtheria cases showed mastoid involvement; 26 per cent. of the scarlet fever cases, and but 14 per cent. of the measles cases had mastoiditis.

It seems to the writer that two points should be impressed on the public. First, the importance of taking care of a cold in the early stages, and second, the necessity of isolating such a case, thus preventing the communication of the germ to possibly every one coming in contact with the patient. A nasal spray should be used daily as routine treatment, especially during epidemics of influenza and by patients leading sedentary lives and exposed to high winds and dust.

Appearances of the Membrana Tympani.—In the first stage of inflammation the drumhead in the region of Shrapnell's membrane is congested, and the hyperæmia extends along the posterior border of the handle of the malleus. The drumhead becomes gradually pinkish in its entire extent, or of a bluish-red and angry appearance, according to the intensity of the inflammation. Ecchymoses or vesicles filled with serum or blood are sometimes observed on the membrana tympani or on the walls of the external meatus. In cases of intense inflammation, marked congestion of the bony auditory canal occurs, so that it is difficult to distinguish where the bony wall ends and the drumhead begins. Exudation of serum with swelling of the tissues gives the drumhead a sodden and lustreless appearance. When the epidermis peels off, the drumhead may be mistaken for a polypus, on account of its smooth, glistening, and red appearance. Bulging of the membrana tympani is observed most frequently in its posterior half, and this may be due to swelling of the tissues or to interlamellar abscesses, or, more frequently, to a collection of fluid in the tympanum. The most frequent seat of the perforation is in the lower anterior or posterior quadrant of the drumhead. It is occasionally, though very infrequently, found in Shrapnell's membrane. When the latter does occur, the disease is mostly confined to the attic, exudation of fluid being found about the articulation of the malleus and incus, and in Prussak's space. The appearances of the drumhead in such cases are intense redness in its upper portion, in Shrapnell's membrane, and in the wall of the canal adjacent to it, followed by bulging of the membrana flaccida. If the tissues are not incised at an early date, perforation is apt to result and pus is discharged. The perforation in such cases may heal and the hearing be restored, or adhesions between the ossicles and walls of the tympanum may form and give rise to considerable disturbance of hearing, or the disease may become chronic, when caries of the ossicles is the usual result. In *influenza cases* the drumhead is markedly injected and angry looking, as a rule, and in some cases the perforation has a nipple-shaped projection in the posterior half of the drumhead, out of which the pus escapes with difficulty. Marked pulsation of the fluid will be noticed at this point. In some cases not only the bony canal, but the cartilaginous portion as well is inflamed. Especially is this the case when otitis media results from injuries to the canal and drumhead from the improper use of instruments or caustic applications. At times the lymphatic glands behind the ear are enlarged. After the discharge has filled the canal, the landmarks are not easily made out, so that it becomes necessary to remove the secretion by syringing and by using absorbent cotton on the end of a cotton-holder before the site of the perforation can be discovered. Cases in which the discharge consists largely of stringy mucus are, as a rule, extremely difficult ones to cure.

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[1] Transactions Ninth International Otological Congress, Boston, Mass., Aug. 12, 1912.

Symptoms. The disease usually commences with pain of an excruciating and lancinating character in the ear, not limited, however, to the ear, but shooting in the direction of the teeth, the neck, and in the occipital, parietal, or temporal region. The pain is more intense at night than during the daytime. As previously mentioned, perforation may occur without pain in the case of tuberculous subjects. In some persons the pain is not very marked, particularly in adults, but such cases are infrequent. The temperature is usually considerably elevated in the case of young children—as high as 105° F.—and in many of them there is little if any pain. In adults the temperature varies very much, usually from 100° to 102° F. After perforation has occurred the pain, as a rule, becomes much less severe, and occasionally ceases at once.

In young subjects, meningitis sometimes is suspected on account of a very high temperature, and from the fact that the child puts its hand to the side of the head. In some children the disease is ushered in by a convulsion or severe vomiting. A child that has been screaming with pain, and that has been on the verge of a convulsion, will suddenly fall asleep, and the temperature will drop several degrees, as soon as, perforation has taken place.

Other symptoms complained of are tinnitus, which is described by the patient as being of a roaring, hissing, hammering, or pulsating character, such noises probably being due to secretion covering the ossicula and fenestræ ovalis and rotunda, or to a hyperæmic condition of the labyrinth, with possibly exudation; giddiness and fulness in the head, and deafness, which may be very slight or well marked, depending on the intensity of the disease, the nature of the secretion, and especially as to whether the labyrinth is implicated or not. After perforation the hearing-distance usually is improved. Patients generally hear the watch or acoumeter through the cranial bones. In severe cases of scarlet fever or diphtheria in which the labyrinth is involved or in which acute caries follows, or in cases of syphilis, this power of hearing the watch or acoumeter will be lost. In Weber's test the vibrations of the tuning-fork usually are perceived better by the affected ear.

Course and Complications. Perforation may occur in a few hours, or it may be three or four days or longer before the discharge makes its appearance. Even after perforation has taken place, the pain at times is severe. In such cases it is probable that the periosteal layer is involved or that the mastoid cells are implicated.

As a rule, after perforation, all symptoms, such as pain, fulness in the head, and giddiness, are considerably modified. The duration of the suppurative stage varies from several days to three weeks, or the disease may become chronic. A cicatrix may or may not mark the seat of the perforation. During the stage of resolution the membrana gradually loses its deep-red color and takes on a grayish-red appearance; the landmarks gradually reappear, viz., the handle of the malleus and the short process. (See Plate I., Fig. G.) In some cases adhesions form between the ossicula and the tympanic walls, and disturbances of hearing result. Opacities, calcareous deposits, atrophic changes, and thickening of the drumhead are observed in other instances.

Acute purulent otitis media is apt to follow a much more protracted and severe course in those who are debilitated or scrofulous, or who are suffering from one of the exanthematous diseases, diphtheria, bronchitis, etc., than when it occurs in a patient who otherwise is healthy and strong. In cases occurring during the course of scarlatina, diphtheria, measles, and influenza, the inflammation is frequently of an intense and virulent nature, and unless a free incision is made at an early date in the drumhead caries of the ossicles and tympanic walls is the result. To emphasize this point, I would refer to a case of scarlet fever that came under my care a few years ago, and in which acute suppurative inflammation of the right ear had already taken place at the time of my first visit. The left ear subsequently became inflamed and painful: a free incision was made in the drumhead, with the result that the left membrana tympani subsequently healed and the hearing on this side became normal, while in the right ear, in which the perforation had taken place spontaneously, the greater portion of the drumhead was destroyed.

Permanent disturbances of hearing occur in cases in which the ossicula are bound down by adhesions, or in which there is an adhesion between the drumhead and middle-ear walls, or in which thickening or atrophic changes or calcareous deposits are observed in the drumhead. Deafness is often well marked when great destruction of the drumhead and ossicula takes place, and especially when the labyrinth is affected.

Beside caries of the ossicula and walls of the tympanic cavity, as a result of acute suppurative otitis media, other complications that occasionally follow are acute mastoiditis, facial erysipelas, meningitis, pyæmia and septicæmia, thrombosis of the lateral or other sinuses, suppurative labyrinthitis, hemorrhage from the internal jugular vein or carotid artery due to acute caries of the temporal bone, and epidural and cerebral abscesses. I have reported two cases in which erysipelas developed suddenly as a complication of acute purulent otitis media, the disease involving the scalp and face and giving rise to considerable constitutional disturbance. When erysipelas first makes its appearance the discharge from the middle ear becomes much less in quantity or ceases altogether. Erysipelas is undoubtedly due to bacterial invasion of a wound by Fehleisen's streptococcus erysipelatis. In both cases referred to the auricle first was affected. I have reported also a case of pyæmia occurring in connection with acute purulent otitis media in which recovery ultimately took place.

That teething is a cause of acute purulent otitis media was clearly demonstrated in the report of a case[1] of a child who came under my observation, and who had very high temperature and symptoms of brain complication. The mastoid antrum was carious, and it was

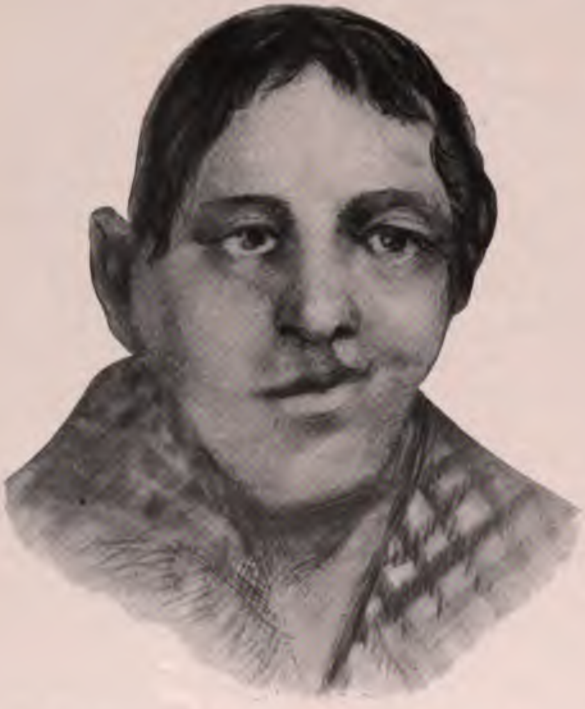
[1] Annals of Ophthal. and Otol., January, 1894, vol. iii, No. 1.

necessary to scrape it with sharp spoons. The disease was undoubtedly due to sympathetic irritation from the cutting of four molar teeth; the child recovered. When pain persists after the appearance of the discharge, and especially if the temperature is high, such indications generally point to mastoid disease or some other complication.

Diagnosis. Before perforation has occurred, it is impossible to make a differential diagnosis between acute catarrhal and acute purulent otitis media, as in both diseases the first stage is marked by hyperæmia of the drumhead. As previously mentioned, the hyperæmia is usually more marked and the pain more intense in acute suppurative otitis media. Acute myringitis may be mistaken for acute otitis media. In the former, however, the pain is not so severe, nor is the disturbance of hearing so great as in the latter disease. If there is stringy mucus in the discharge from the ear, one may safely diagnose acute purulent otitis media, as mucus is never present in a case of otitis externa or furuncle of the canal. After removal of the discharge by syringing or by means of absorbent cotton on a cotton-holder, inspection with head-mirror and speculum will usually reveal the seat of the perforation.

In cases in which the latter cannot be seen on account of the curvature of the external auditory canal, a perforation whistle may often be heard by having the patient try the Valsalvian method of inflating the ear, or by Politzer's method. This experiment will not succeed, however, when there is great swelling of the Eustachian tube or when the perforation is in Shrapnell's membrane. It should not be forgotten that in some cases of acute purulent otitis media the discharge is composed almost wholly of pus. Malignant disease having its origin in the temporal bone may give rise to great difficulty in the diagnosis during the early stage. I have reported the case[1] of a woman (see Fig. 73) who complained for some time of pain with tinnitus in the right ear, followed by a slight serous discharge. Facial

FIG. 73.



Case of carcinoma of the temporal bone, giving rise to facial paralysis.

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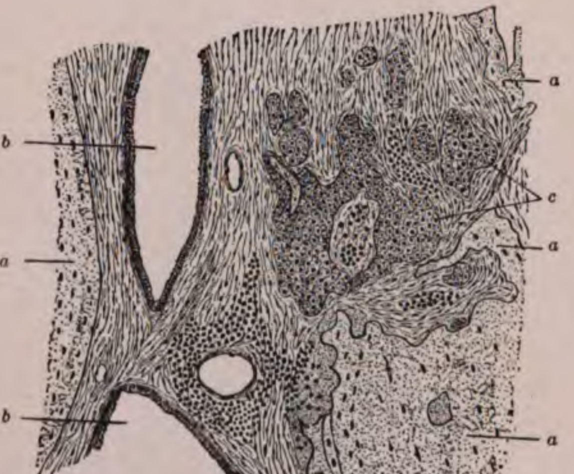
[1] Archives of Otology, 1888, vol. xvii. No. 1.

paralysis caused her considerable alarm, so that she sought advice. There was marked induration of the tissues in front of the ear, extending toward the jaw. The pain became very severe, as is usually the case in such patients, an important point to consider, for when it is persistent and cannot otherwise be accounted for, malignant disease should be suspected. This case proved to be a carcinoma, as shown in Figs. 74 and 75. Another case with a similar history also came under my care.

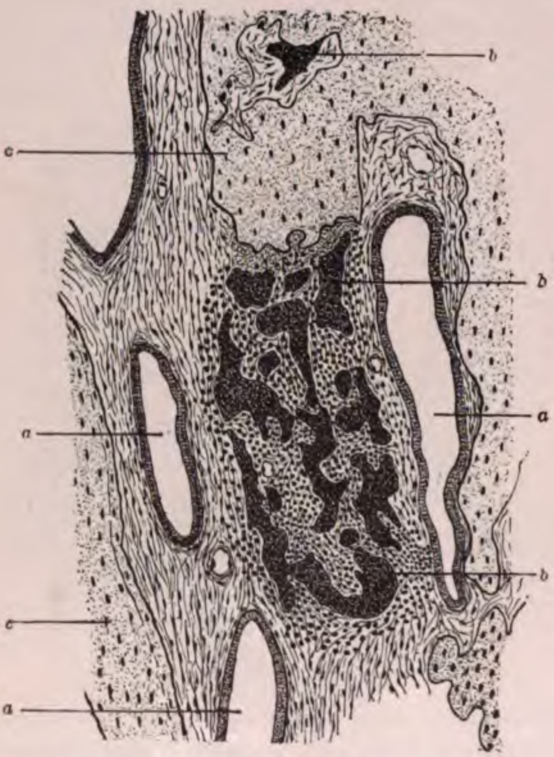
FIG. 74.



a. Trabeculæ. *b.* Mastoid sinuses. *c.* Carcinoma.

Prognosis. In simple cases of acute purulent otitis media occurring in healthy individuals when due to cold or nasopharyngeal catarrh, the prognosis is good if the case is treated properly. The prognosis is, however, unfavorable in cachectic, scrofulous, tuberculous, and syphilitic patients; also in severe cases of diphtheria, scarlet fever, measles, and typhus fever. In some cases of influenza a favorable prognosis should not be given. One should consider the following as unfavorable symptoms, viz., a distressing tinnitus; fever; severe pain,

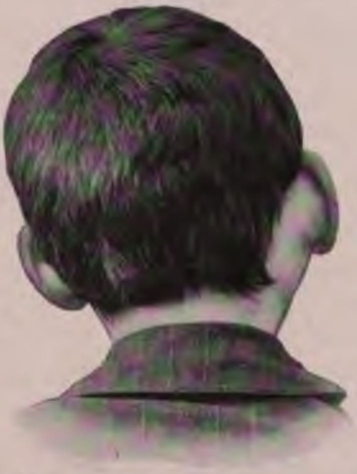
FIG. 75.



a. Mastoid sinuses. b. Carcinoma. c. Bone trabeculæ.

which has been more or less continuous for several weeks; a profuse discharge, which has persisted in spite of treatment; hemorrhage from the ear, caused in most instances by granulations or polypi; great destruction of the membrana tympani; symptoms of mastoid disease; swelling of the bony auditory canal; caries of the ossicula and walls of the middle ear; facial paralysis, and enlargement of the lymphatic glands in the neck. Facial paralysis sometimes, although very infrequently, manifests itself in simple acute otitis media even when perforation does not occur, but in such instances even the paralysis generally disappears in a few days.

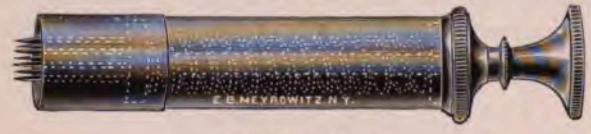
FIG. 76.



Malignant growth of temporal bone.

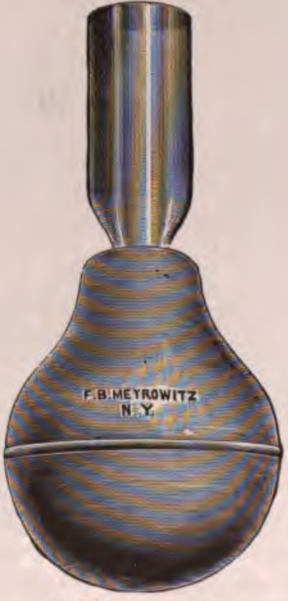
Treatment. In uncomplicated cases the patient should be kept quiet in the house, while in severe cases he should be put to bed and given a light diet. A triturate tablet of calomel, gr. one-tenth to one-quarter, should be administered every hour for six doses, or until a slight laxative action is produced. Aconite in drop doses is also a most valuable remedy when there is fever, and especially in cases due to cold. Tincture of pulsatilla, likewise given in drop doses, is indicated also in

FIG. 77.



Author's scarificator.

FIG. 78.

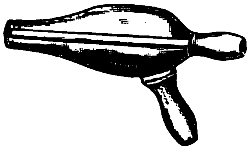


Author's cupping-glass.

cases in which there is a profuse discharge from the nares or nasopharynx, and may be administered alternately with aconite. The author formerly used the artificial leech with satisfactory results in many cases, especially those of a mild type, and still feels that in certain instances it can be used to advantage. The artificial leech consists of a scarificator (Fig. 77) and cupping-glass (Fig. 78). The scarificator has seven lance-shaped needles, and the depth of the punctures made in the soft tissues can be regulated by screwing or unscrewing the cap on the end of the instrument. The latter being placed in front of the tragus or over the mastoid, according to the indications, the spring is then pulled back and the tissues scarified. The cupping-glass is immersed in hot water for a few seconds and then applied over the bleeding surface. The artificial leech is much to be preferred to the natural one, for the following reasons: 1. The scarificator and cupping-glass are always at hand, while natural leeches are frequently very difficult to obtain, especially at night. 2. Leeches are very repulsive and disagreeable to most patients, and especially to children. 3. After the artificial leech has been removed, the bleeding ceases at once, while with the natural leech it is often difficult to control the hemorrhage. I have known of cases in which alarming hemorrhage occurred after the surgeon left the patient.

In the case of children, hot water instilled into the ear often affords great relief, as well as douching the ear every hour or two with a warm boric acid solution. In douching the ear, the Lucæ glass tip can be used to advantage. After being connected to the douche-bag by rubber tubing, it is inserted well into the external auditory canal. The water enters through the upper opening and escapes from the lower one (Fig. 79). Some patients derive much comfort from the application of dry heat by means of a hot-water bag or hot bag of salt. Lucæ uses hot compresses about the ear soaked in a solution of acetate of aluminium, two drachms to the pint of water. Drops of sterile oil containing 4 per cent. of cocaine or 10 per cent. of opium may be used with benefit (see p. 167). All drops and solutions for the ear should always be warmed.

FIG. 79.

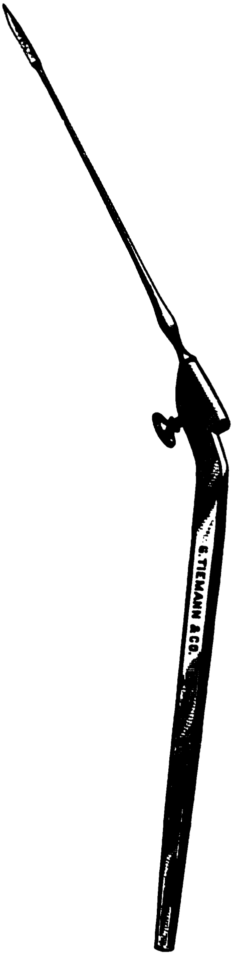


Lucæ's glass tip for the aural douche.

The condition of the pharynx, nasopharynx, and nares should be noted, and treatment directed to the parts whenever necessary. (See Chapter VII.)

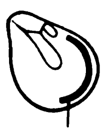
As micro-organisms travel from the pharynx and nasopharynx to the middle ear by means of the Eustachian tube, it is of the greatest importance in cases of measles, scarlet fever, diphtheria, and influenza to try to prevent the disease from extending to the middle ear. To accomplish this, sprays of boric acid or Dobell's solution, or carbolic acid are indispensable, while the ears should be examined frequently for the first evidences of inflammation. A rise in temperature will frequently be the only symptom of acute suppuration of the middle ear in cases of scarlet fever, measles, or diphtheria. A sudden rise in temperature is a much more important symptom than pain in the aural complications of the exanthemata. As the micro-organisms in these diseases are apt to cause acute caries, it is very important that the surgeon should make an *early incision* in the drumhead, and not wait until perforation has occurred through ulceration. A *free incision* should be made with a bistoury (see Fig. 80), and *not a paracentesis, as formerly was practised,* the line of incision extending from just behind the stapes to the lower border of the drumhead and close to the bony auditory canal (see Fig. 81). In some cases, particularly where there is bulging of the membrana tympani in its upper and posterior quadrant, complicated with symptoms of acute mastoiditis, the knife should be carried well up to the posterior fold of the drumhead and into the attic, so as to drain more fully that cavity, as well as the aditus ad antrum. The knife should then be brought out along the upper posterior wall of the ex-

FIG. 80.



Author's knife for incising the membrane tympani and for dividing adhesions.

FIG. 81.



Line of incision.

ternal auditory canal, so as to relieve the tension frequently observed in this locality. If one is not an expert, and has had but a limited experience in operations on the drumhead, it is much wiser to make a perpendicular incision in the membrana from a point just below the umbo to the lower wall of the tympanum. Some advocate making an incision like a St. Andrew's cross, as there is a constant tendency for the opening to close. Before incising the drumhead, the auditory canal should be syringed with a bichloride solution (1:5000), and thoroughly dried with sterile absorbent cotton. As incision of the drumhead is an extremely painful operation, it is generally advisable to administer an anesthetic. In young children chloroform may be given, but great care should always be used in its administration. Nitrous oxide gas is to be preferred in the case of adults. A convenient apparatus for this purpose has been manufactured by the S. S. White Dental Manufacturing Company, which can be conveniently carried by the surgeon. Ethyl chloride has also been used lately in an inhaler especially designed for this purpose, but the author believes that it can be safely administered only with a chloroform mask or other open inhaler. When an anæsthetic is contraindicated for any reason, the pain can be modified by painting the drumhead with Gray's mixture (p. 361). Some advocate the use of equal parts of menthol, carbolic acid and cocaine rubbed together in a mortar, and then carefully applied with an applicator along the line of the proposed incision. This is not always a painless method, and is not usually as satisfactory as a general anæsthetic. After the membrana has been incised, the object of treatment should be, first of all, to promote the discharge as much as possible by douching the ear with the normal salt solution or a solution of boric acid, ʒj to water ℥viij, or a 1–2 per cent. solution of aluminium acetat. (Kirchner), or a 1–2 per cent. solution of lysol; and, secondly, to try to destroy the micro-organisms. A bichloride solution (1:5000) can be used to advantage after the discharge has become profuse, as well as a solution of formalin (20 drops to a pint of water), and especially in cases in which the infection is of a virulent character. After douching the ear, which in some cases is necessary every hour or two, according to the amount and character of the discharge, it is advisable to insert a strip of boric acid or iodoform gauze down to the membrana tympani by means of a probe, as this procedure helps to drain the ear.

In all cases of acute otitis media due to cold or the influenza, the drumhead should be incised as soon as any bulging of the drumhead is apparent, as well as in those cases in which pain and fever persist in spite of all antiphlogistic treatment. In other instances in which spontaneous rupture has taken place, and in which the perforation is very small, the latter should be enlarged. In some cases, after incising the drumhead, no discharge will appear for several hours, while in others it is so thick and tenacious that it is necessary to force it from the middle ear into the external meatus by means of Politzer's method. Great care should be exercised in inflating the ear, especially in the early stage, for fear of increasing the inflammation, and under no circumstances should this be done unless there is a large perforation in the drumhead. When the discharge is thick and tenacious, its removal may be facilitated by means of Siegle's otoscope.

If the bulb of the internal jugular vein runs an anomalous course and projects into the middle ear, as sometimes, but very infrequently, occurs, it is easy for the surgeon to wound it when incising a drum membrane as occurred in a case reported by Max[1]. The patient had an acute otitis media with a bulging drumhead which was incised. At first a few drops of bloody serum escaped but it was followed immediately by a stream of dark blood. The canal had to be tamponed. The boy was four years old. A month later an examination showed that the whole posterior inferior and a portion of the anterior inferior quadrant of the drumhead appeared bluish white and behind the drumhead one could see a rounded body which became fuller and the bluish white color more intense when pressure was made on the internal jugular vein. There was an identical appearance of the drum membrane on the other side.

After the more acute symptoms have begun to subside, a saturated solution of boric acid should be warmed and instilled into the ear several times a day after the discharge has been thoroughly removed by syringing or by absorbent cotton on a cotton-holder. Some cases do well under the so-called dry method of treatment, consisting in the insufflation of various powders into the external meatus, principally boric acid, or of aristol, dermatol, or europhen. After the canal has been thoroughly cleansed of all secretion and dried as before, boric acid powder is insufflated, by means of a powder-blower, into the external auditory canal, but should never be packed in, as pyæmia has followed such practice. The dry method should not be employed until all acute inflammatory symptoms have subsided, and never in cases in which there is a small perforation, nor in which there is considerable thick and stringy mucus. Hydrastis canadensis may be combined with boric acid as follows: A paste is made of boric acid and tincture of hydrastis canadensis, and the mass, after it is dry, is thoroughly pulverized and mixed again with equal parts of boric acid powder. Astringent solutions are indicated in cases in which the treatment by boric acid solution or powder has not succeeded. For this purpose, sulphate of zinc, or sulphate of copper, or acetate of lead, in the proportion of three to eight grains to the ounce of water, is generally prescribed.

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[1] Monatschr. f. Ohrenh., May, 1904.

Injections of warm water through the catheter into the middle ear are recommended by Politzer in cases in which the pain is persistent and does not yield to the usual remedies; also in those cases in which the discharge cannot be arrested by local treatment; and especially in cases in which there is a small perforation (nipple-like) in the membrana tympani, and likewise in cases in which the mastoid process is involved. Whenever the mastoid cells are implicated, the treatment described in the chapter on Mastoid Diseases should be followed. All polypi should be removed by curettes, the snare, or caustic applications. It is of the same importance to attend to the patient's general health in this disease as in acute catarrhal otitis media. The internal administration of urotropine is advisable in many cases, particularly in those of a virulent infection. After the perforation has closed, it is advisable at first that the patient wear a small piece of cotton in the meatus, especially during unseasonable weather. The middle ear should be inflated several times a week, and gradually less frequently until the hearing is entirely restored; and the patient should be cautioned to be very careful about exposing himself to draughts and sudden changes in the weather.

CHAPTER VII.

ADENOID GROWTHS, ENLARGED TONSILS, DISEASES OF THE NASAL PASSAGES.

As diseases of the ear are associated so frequently with affections of the nasal passages, the nasopharynx, the Eustachian tubes, and the tonsils, it not only falls within the province of the aural surgeon, but also becomes his duty to examine most carefully into the condition of these structures and passages as well as to apply proper treatment. When the Eustachian tubes are constricted or the patient is unable to breathe through the nose, owing to some obstruction in the nasal passages or to the presence of adenoid growths in the nasopharynx, so that proper ventilation of the middle ear is interfered with, it is useless for the surgeon to practise repeated inflation of the ears by Politzer's method, with the expectation of effecting permanent relief, without first removing the cause of the occlusion.

Great attention has of late years been paid to the treatment of the nose and nasopharynx, and much benefit has resulted from this practice.

When a patient has been deaf for a considerable length of time and serious changes have taken place in the drumhead, with adhesions, and especially if there is tinnitus, one should be very guarded in expressing an opinion as to the benefit to be derived from treatment of the nasopharynx and nares. Too frequently one sees patients, the victims of chronic catarrhal otitis media, who have undergone operations on the nose and nasopharynx without any improvement in the hearing. It is in the more recent cases that one is apt to meet with success, before permanent pathological changes have taken place in the *membrana tympani.*

ADENOID GROWTHS.

To Dr. Wilhelm Meyer, of Copenhagen, is due the honor of having first directed the attention of the medical profession to the great importance of removing adenoid growths in the nasopharynx, especially when their presence interfered with the passage of air through the nose and Eustachian tube.

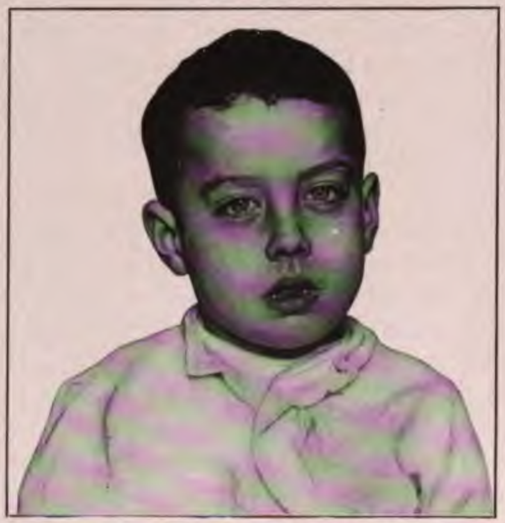
Others have followed in Meyer's footsteps, so that at the present time the operation of removal of these growths is performed frequently, and with much success. Not only has deafness been cured in many instances by the excision of an adenoid growth, but diseases of a nervous character, such as asthma, false croup, as well as malformations of the chest, nose, and throat, have been benefited by this operation.

The examination of the ear should never be considered complete until the nose and nasopharynx have been most carefully examined, more especially in the case of children. In about 74 per cent. of Meyer's cases of adenoid disease there was more or less deafness.

As usually observed, adenoid hypertrophy at the vault of the pharynx is of two varieties. In one there is more or less fibrous tissue associated with the lymphoid mass, while in the second variety it is very scarce. The growths vary much as to size and number. There may be simply a chronic enlargement of the pharyngeal or

Luschka's tonsil, situated at the roof of the nasopharynx, which may fill the space entirely, or the growth may be so small that the surgeon is not justified in removing it. The vegetations may extend from the vault along the posterior and lateral walls of the pharynx, or one large mass or several smaller growths may be found on the posterior pharyngeal wall. The adenoid tissue is, as a rule, bright in color, and bleeds readily when examined with the finger or probe.

Fig. 82.



Typical facial expression of a patient with adenoid vegetations in the nasopharynx.

Symptoms. The expression of the face is exceedingly characteristic of this disease, as well as the manner in which the patient pronounces certain words. There is difficulty in pronouncing sounds of m, n, and ng, so that the patient talks, as it were, "through the nose."

As a result of mouth-breathing, the patient presents a stupid and listless appearance (see Fig. 82); he is anæmic; has drooping eyelids, prominent teeth, and arched palate. He may have what is known as a "pigeon-breast"; he is apt to complain of frontal headache, a feeling of fulness in the nasopharynx, and the sense of smell is impaired. There is apt to be a persistent catarrh with considerable secretion. The nose becomes pinched, and the alæ have a sunken appearance. Snoring is a prominent symptom. As a result of the obstruction to respiration through the nose, deformity of the septum may occur. The appearance of the face, in consequence, may be changed, owing to the imperfect development of the osseous structures of the nose and hard palate. The hearing becomes affected when the normal ventilation and nutrition of the middle-ear tract are interfered with. The mucous membrane at the mouth of the Eustachian tube becomes swollen as a result of frequent head colds, or the vegetations themselves may encroach upon the orifice of the tube. In consequence, the patient complains of earache, tinnitus, and impaired hearing; and if this condition of affairs is allowed to continue without treatment, permanent changes take place in the structures of the middle ear, so that the drumhead becomes retracted, adhesions develop, or the drum membrane becomes perforated from a suppurative process. Enlarged tonsils often are observed at the same time, especially in children.

Causation. Adenoid hypertrophy is much more frequently seen in children than in adults. In fact, after puberty one meets only occasionally with these growths, although they may be found in rare instances in elderly persons, as well as in infants at birth. Hereditary influences undoubtedly play an important rôle in the causation, as well as residence in damp places. They occur sometimes as a result of scarlet fever, measles, diphtheria, debilitating fevers, scrofula, and hereditary syphilis.

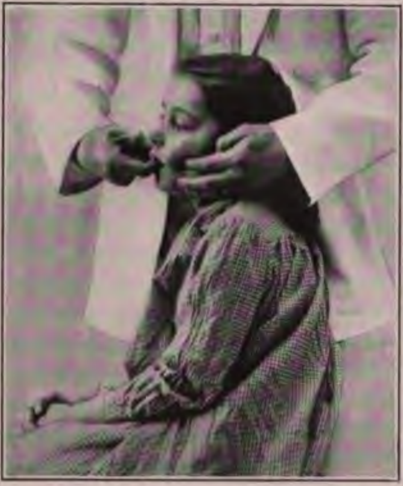
Diagnosis. In adults, one can usually make a diagnosis of adenoid hypertrophy by means of the head-mirror and posterior rhinoscopy. With children, however, it is usually impossible to obtain a satisfactory view of the nasopharynx by such means. The surgeon should make a digital examination as follows: The examiner stands to the right of, and a little behind the patient, who is in a standing or sitting posture according to the age, with the head thrown back and resting against the surgeon. In infants and small children it is convenient to have them on the lap of the mother or nurse, the general position of patient and examiner remaining the same.

The patient's mouth is gently forced open by the left index finger, and the left cheek gently but firmly pushed between the patient's jaws. This acts as an automatic mouth gag and prevents injury to the finger of the examiner. The index finger of the right hand is now inserted along the dorsum of the tongue until the uvula and edge of the soft palate are reached. It is then passed upward between the palate and the posterior pharyngeal wall, and the adenoid tissue if present will be felt as a soft lobulated mass or as isolated nodules in different parts of the pharyngeal vault, occasionally impinging on the mouths of the Eustachian tubes. If adenoid tissue is not present, the pharyngeal walls will be smooth and resistant.

After thoroughly exploring the nasopharynx, noting the size, location, and consistency of the adenoid tissue, the examiner's finger is withdrawn. This will often be covered with bloody mucus, an additional indication of the presence of adenoid tissue.

Up to this time the index-finger of the surgeon's left hand has pressed the cheek firmly between the patient's jaws. If this is removed too quickly, the examiner's finger is likely to be injured by the patient's teeth.

FIG. 83.



Method of examination for adenoids.

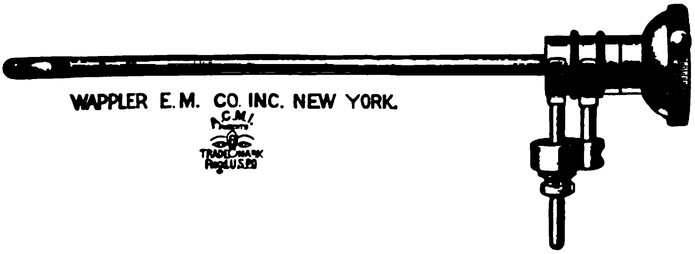
Dr. Edgar M. Holmes,[1] of Boston, has recently perfected an instrument on the principle of an illuminated cystoscope, by which, when passed through the nostril, one may observe the condition of the pharyngeal orifice of the Eustachian tube and its immediate neighborhood.

[1] Transactions Ninth International Otological Congress, Aug. 12, 1912.

Its field of vision is necessarily limited, but it is especially useful to supplement the posterior rhinoscopic mirror, and to obtain a view of the nasopharyngeal structures when an introduction of the mirror is impossible.

It gives a direct image, and it is passed through the inferior meatus and revolved, so that the Eustachian orifice of the same side and the vault of the pharynx and the tube of the opposite side are successively brought into view.

Fig. 84.



Nasopharyngoscope.

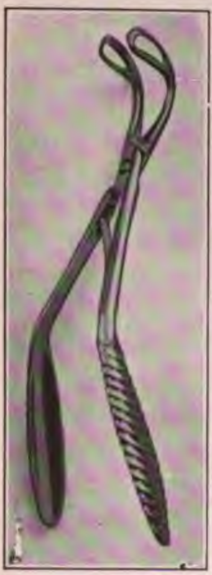
Treatment. Much may be accomplished by the administration of tonics and alteratives, especially if the general health is impaired. The syrup of the iodide of iron, the syrup of hydriodic acid, and cod-liver oil are remedies that are especially indicated. The most satisfactory and efficient method, however, is the surgical treatment of this condition. In a certain number of patients who give the history of being "bleeders," it is prudent to test the coagulability of the blood before advising operation. If the coagulation time of the blood is found to be above the normal limit, operation is contraindicated until the coagulation of the blood can be restored by the injection of horse serum or by transfusion. As regards operative interference, many various instruments have been devised for this purpose.

Meyer himself used an annular knife, one centimetre in diameter and twenty-one centimetres in length, which he inserted with the right hand between the septum and the spongy bones as far as the nasopharynx. By introducing the left forefinger through the mouth and behind the soft palate until he felt the instrument, he pressed the vegetations inside the ring. By drawing the knife outward, the growths were cut off. He further recommended a second method, viz., cauterization with solid nitrate of silver.

In adults the adenoid hypertrophy may be removed without an anæsthetic in many instances; but in children, according to my experience, it is always advisable to use ether. Ether is to be preferred to chloroform, as being safer, and the patient should not be completely anæsthetized, for fear of blood entering the trachea. The instruments that have been most satisfactory in my hands are the Knight or Brandegee forceps.

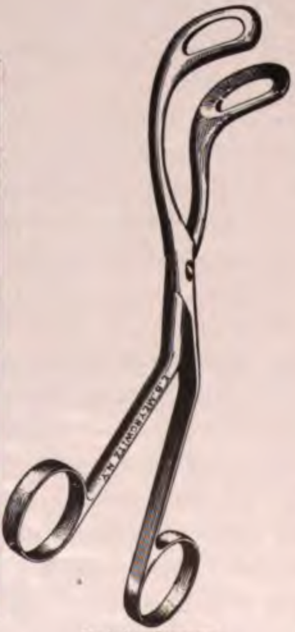
THE AUTHOR'S METHOD. In operations upon tonsils and adenoids the author now employs an aspirating machine. This has a mouthpiece, easily sterilized, which is operated by the assistant. It is of great value in keeping the operative field free of blood, and in preventing blood and mucus from entering the trachea. The patient is anæsthetized and placed in a recumbent position on an operating-table, and a mouth-gag is inserted on the right side of the mouth. The operator, standing on the left side of the patient, introduces the forefinger of his left hand into the nasopharynx, to locate the position of the growth as well as to guide the point of the instrument.

Fig. 85.



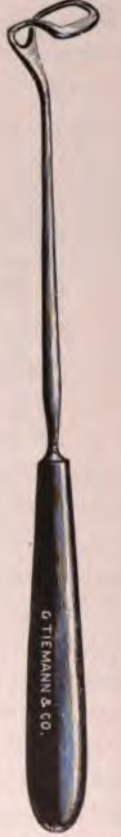
Brandegee forceps.

Fig. 86.



Knight forceps.

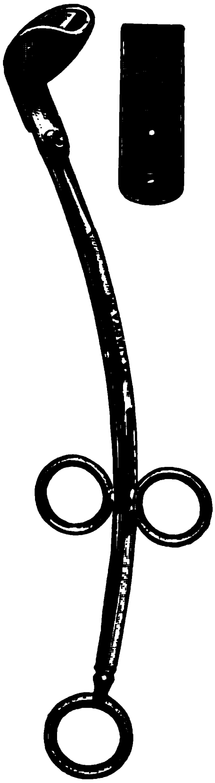
Fig. 87.



Gottstein curette.

The Knight or Brandegee forceps (see Figs. 85 and 86) are admirably adapted for the removal of these growths. They are introduced closed, and afterward opened, so as to include all of the growth if possible. The patient should be turned to the right side from time to time to allow the blood to flow out of the mouth and nose. Some blood is swallowed and frequently vomited after the operation. There is less danger that fragments of the growth will fall into the larynx by this method than when the patient is in the upright position. After the operator has satisfied himself that he has removed the growth as thoroughly as possible, he should, for fear of leaving some fragments, scrape the cavity thoroughly with the Gottstein curette (Fig. 87). By means of good illumination the curette is introduced behind the soft palate and kept well forward until the septum is reached. At this point the instrument is pushed firmly backward and then drawn downward over the posterior pharyngeal wall. The last few years have witnessed the increasing popularity of the La Force adenotome. (Fig. 88.) This is a box-like instrument with a flexible cutting blade, working from below upward. In using it the chin is extended, the instrument with the blade open is introduced high up in the median line behind the palate and pressed firmly against the pharyngeal vault and vomer, forcing the adenoid into the cavity of the instrument. The blade is then pushed home, severing the adenoid mass which remains in the box of the instrument. At first a small amount of adenoid tissue is apt to be left posterior to the vomer and around the Eustachian tubes, but with increasing skill it will be found a satisfactory instrument for the removal of the majority of adenoids, especially in children. To control the hemorrhage, the nares should be thoroughly sprayed with ice cold Dobell's solution and the face and neck sponged with towels soaked in ice-water while the patient is in the recumbent position.

Fig. 88.



La Force adenotome.

The patient should be prepared beforehand for the operation. The evening before, a mild purgative should be administered; he should be given a light diet on the day of operation, and there should be at least four hours' interval between the last meal and the time of the operation.

Cases of severe hemorrhage after operation have been reported, but they are infrequent, and when they do occur are probably due to the hemorrhagic diathesis. Burger[1] reports the case of a child, eleven years of age, who suffered from leukæmia and who died of hemorrhage after removal of adenoids. According to this writer the danger of hemorrhage increases with age as in seventy-eight cases reported, fourteen were over fifteen years of age. He regards the particles of adenoid tissue which remain after excision as the most important source of the bleeding. On this account, it is important for the surgeon to be well informed as to the patient's general condition. The operation should never be undertaken if the patient has a cold or symptoms of otitis media, for in a case[2] that I reported, in which the operation was performed when the patient was suffering from an acute pharyngitis, not only did purulent otitis media follow, but it became necessary to open the mastoid cells. Great care and gentleness should also be employed when operating, for fear of injuring the mouths of the Eustachian tubes.

After the operation the patient should be watched until the hemorrhage has ceased, and should then immeditately be put to bed and kept in a recumbent position for at least twenty-four hours, and for several days should remain quiet in the house. During this time the diet should be a *simple* one.

In some cases a second operation is required, even if all the growth was removed the first time. In other cases, especially in adults, the remnants of the adenoid growth should be cauterized with solid nitrate of silver.

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[1] Presse oto-laryngologique Belge, 1904, No. 4.

[2] Transactions of the American Otological Society, 1892.

If the tonsils are enlarged, it may be necessary to excise them, as well as to perform some operation on the nasal passages, in order that the patient may breathe easily with the mouth closed.

When the child has been in the habit of breathing with the mouth open for a long period of time, it may be necessary to apply a bandage, or a special apparatus designed for this purpose, to prevent the jaw from dropping at night, and this should be worn for some little time or until the habit has been corrected.

In case of severe hemorrhage, applications of a solution of tannic and gallic acids should be made, or it may be necessary to plug the posterior nares. Great care should be exercised so that the patient does not take cold after the operation. Usually after the operation there is a decided improvement in the hearing, provided the latter has not been affected for a long time and permanent changes have not taken place in the drumhead. Even in cases in which there is a discharge from the middle ear the suppuration generally becomes diminished at once. The patient's general health is, as a rule, much improved after the operation. I have seen children who were sickly, poorly nourished, and anæmic, show a decided change for the better after removal of these growths. The following case illustrates this point: A boy, aged four and one-half years, weak-minded, poorly nourished, breathes with mouth open and is very restless at night. There has been a discharge from the ear for about two weeks. Under ether an examination of the posterior nares was made with the index-finger, and the vault was found filled with adenoid masses. These were removed with the Gradle forceps. There was considerable hemorrhage, which soon ceased. Two weeks later there was a very decided improvement in the child's general appearance, as shown by his breathing and sleeping better, and being in much brighter spirits. The hearing was much improved and the discharge less. His mother was very enthusiastic over the good results of the operation.

It does not follow that improvement in the hearing will take place after the operation without treatment directed to the ear itself, for frequently the drumhead is considerably retracted and bound down by adhesions, so that it will be necessary to restore the drumhead to its normal position.

ENLARGED TONSILS.

Enlarged tonsils, or chronic hypertrophy of the tonsils, are undoubtedly an indirect cause of deafness in that they interfere often with nasal respiration, and by pressure upward prevent the proper ventilation of the tympanic cavity. When removed, the hearing-distance is often much increased, but the surgeon should always examine the nasopharynx, for usually in children adenoid hypertrophy is associated with enlarged tonsils.

Hypertrophy of the tonsil consists of a proliferation of its fibrous stroma, together with an unusual increase of its lymphoid tissue. The proliferation of its fibrous stroma is observed more frequently in cases of long standing.

Causes. Enlarged tonsils are frequently due to malnutrition, scrofula, syphilis, tuberculosis, rheumatism, and indigestion. Exciting causes are frequent attacks of acute inflammation from cold, scarlet fever, diphtheria, measles, whooping-cough, and recurring attacks of quinsy sore-throat.

Enlarged tonsils have been observed in children soon after birth. After puberty the tonsils, as a rule, begin to grow smaller, and in some cases resume a normal size and appearance.

Symptoms. The symptoms are very similar to those observed in cases of adenoid hypertrophy. The patient is apt to be poorly nourished, has difficulty in breathing with mouth closed, and there is more or less difficulty in speaking. In some cases the senses of hearing, smelling, and tasting are impaired. Nervous symptoms are sometimes observed, such as spasmodic cough, chorea, and epilepsy.

Treatment. It is advisable to try to reduce the size of the tonsils by internal medication and by local treatment, whenever practicable, before resorting to surgical interference. I think that surgeons are often inclined to operate too early, and in some cases I believe that much can be accomplished without resorting to excision. In some instances cheesy matter may be forced out of the crypts by pressure made on the tonsils. In cases of malnutrition the child should be given cod-liver oil, syrup of the iodide of iron, or syrup of hydriodic acid, for some time before resorting to operative measures.

In cases of the hemorrhagic diathesis, the surgeon should hesitate to advise operation. If absolutely necessary, the tendency to postoperative bleeding may be lessened by the preliminary subcutaneous injection of horse serum.

Until within a few years tonsillotomy was the operation universally adopted, which was performed with or without an anæsthetic, and the Mathieu and the Mackenzie tonsillotomes were the instruments generally used.

Tonsillectomy. In the opinion of the author, however, the time has come when tonsillectomy and not tonsillotomy is the operation of choice. From time to time a number of cases are seen in which two or more years previously a tonsillotomy has been performed and in which now the buried tonsillar stumps have grown to almost their original size, causing a recurrence of the symptoms originally demanding their removal.

It is an operation requiring the exhibition of considerable skill, dexterity, and judgment, and should not be performed by an operator whose experience is limited, and who is unfamiliar with the anatomy of this region.

That the radical operation upon the tonsil is attended by more reaction, and by possibly a greater liability to oral infection than simple tonsillotomy, the author does not deny, but he believes that the permanent and uniformly satisfactory results thus obtained counterbalance by far the objections above alluded to.

Tonsillectomy is a major operation and should be performed in the house or preferably in the hospital.

The author wishes to stamp his emphatic disapproval upon the practice of operating on tonsils and adenoids in private offices and clinics, and allowing the patients to pass almost immediately into the open air, subjecting them to the dangers of infection, secondary hemorrhage, and their sequellæ.

The dangers of this operation can largely be obviated by appropriate pre- and post-operative treatment.

In adults the operation may be performed under local anæsthesia, but in nervous individuals and in children ether should be administered, preferably by the drop method. If the gas-ether sequence is used in children it should be administered by an anæsthetist of special experience in this line of work.

The technique used by the author is as follows:

The operator stands to the right of the patient, who is in the recumbent position and thoroughly anæsthetized. His assistant stands on the opposite side. The jaws are separated with the tongue depressor and the mouth-gag introduced on the patient's left side.

The right tonsil is operated upon first. The tenaculum forceps are engaged in the tonsil, care being taken to include both the upper and the lower pole within its grasp, and gentle traction is then made toward the median line. The assistant then retracts the palate gently upward with the tip of the aspirator. This sharply delineates the line of junction between the tonsil and the posterior pillar. With snips of the curved scissors the mucous membrane is now severed along the junction of the tonsil and the anterior pillar. The posterior pillar is separated from the tonsil by blunt dissection with the closed ends of the scissors. The upper two-thirds of the tonsil is dislocated from its bed, chiefly by blunt dissection, and working from behind, forward. Any firm adhesions encountered are cautiously severed close to the tonsil. If the above procedure has been properly carried out the tonsil will, with gentle traction drop downward and forward, and be held in place only by the fibrous tissue at the base of the capsule, the unseparated portion of the posterior pillar, and the mucous membrane at the base of the tonsil. The separation is rendered more complete by introducing the index finger of the right hand between the tonsil and its bed, and gently pushing it downward and toward the median line. This separates the tonsil so that it hangs only by the mucous membrane at its base.

The pedicle thus remaining is severed by a Peter or Eves snare.

The patient is now turned on the right side and the left tonsil removed in a similar manner. The operation should be performed under good illumination, preferably from an electric head-light, and the operative field sponged or aspirated from time to time in order to remove the blood and mucus. If the tonsils be examined they will in the majority of cases be found to have been completely enucleated with the capsule intact.

If any tonsillar tissue is found to remain, it can now be removed by the careful use of the tonsil punch.

If adenoids are present, they should now be removed in the usual manner. Especial care should be taken to see that the adenoid forceps and curettes are introduced into the naso-pharynx and not into the large fossa left by the removal of the tonsil, a mistake which the author has seen not infrequently.

Before leaving the operating table, after the nares and pharynx have been sprayed with ice cold Dobell's solution and the face and the neck mopped with towels wrung out in ice-water, a final inspection of the operative field is indicated, to see that all hemorrhage has ceased and that all tonsillar and adenoid tissue has been removed.

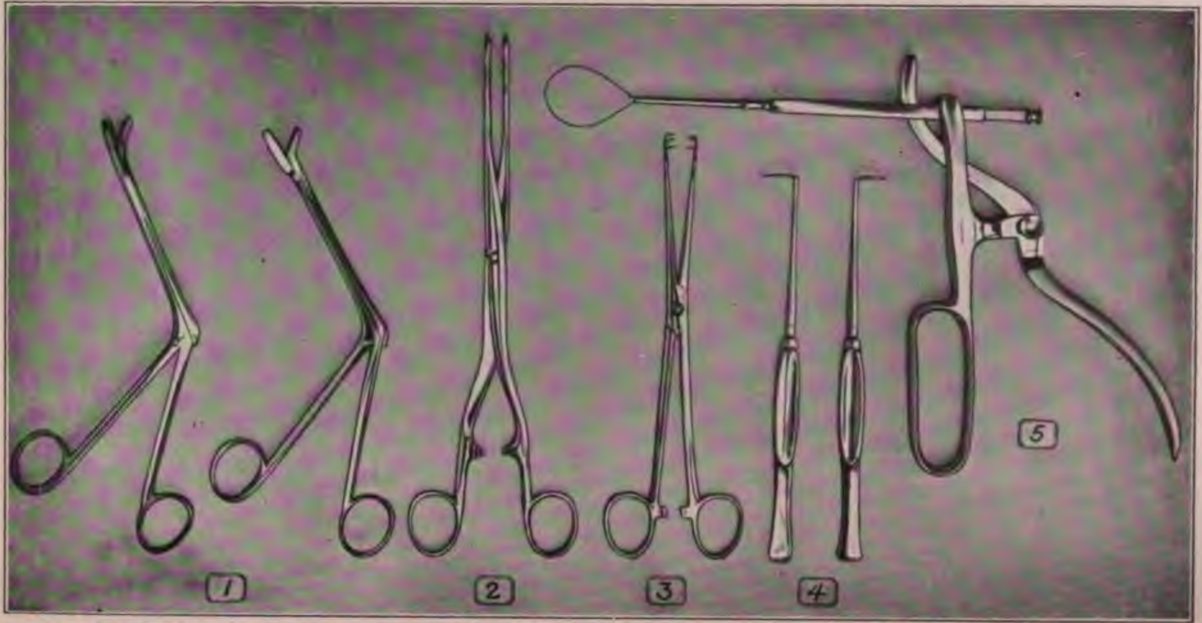
SLUDER METHOD. In a recent article Dr. Sluder, of St. Louis, advocates a method of enucleation with his modified tonsillotome. This is a short, heavy instrument of the Mackenzie or Physick type, with a moderately dull blade. It is introduced from the opposite side of the mouth and pushed against the tonsil. At the same time it is drawn upward and forward, engaging the tonsil against the eminence on the inner surface of the body of the inferior maxilla. Great pressure is now made and the tonsil forced firmly into the aperture of the guillotine. The handle of the instrument is rotated downward, and engagement of the tonsil is furthered by pressing it into the opening by the index-finger of the unengaged hand. The blade is then pushed home. Sluder claims 98 per cent. of complete enucleations by this method. Other operators are not so successful. He admits that the anterior pillar is frequently partly cut away.

The advocates of this operation claim for it quickness, ease, and lessened postoperative reaction.

The author is loath to adopt this method, because the results from the other method have been most satisfactory.

Hemorrhage.—Immediately after the removal of the tonsil, firm pressure is made in the fossa for a few minutes with a gauze sponge coated with vaseline and made large enough to fit snugly. If any spurting vessel is seen after its removal, it should be clamped and the clamps allowed to remain for a few minutes, ligating if necessary. If persistent venous oozing still continues, a vaseline-coated gauze sponge should be inserted into the fossa, and the pillars clamped over it with the Michel-Wagener clamp (Fig. 91). These should be removed in twelve hours.

FIG. 89.



1, Myles tonsil punches (right and left); 2, Sponge holder; 3, Ballinger's tenaculum forceps; 4, Leland's tonsil knives; 5, Peter's snare.

The clamp is simply a large Michel clamp. This should be threaded into the special sliding forceps, the tongue depressed, and the posterior prong of the clamp engaged on the posterior pillar; the pillar is now pulled over the sponge and the anterior pillar caught on the anterior prong of the clamp. The applicator is now closed and the clamp bent together. Care must be taken in applying the clamps that they do not fall into the mouth. When they are to be removed, the extractor (Fig. 90) is applied beneath the clamp and closed; this rebends the clamp into its original shape, and it can then be disengaged and removed.

Fig. 90.

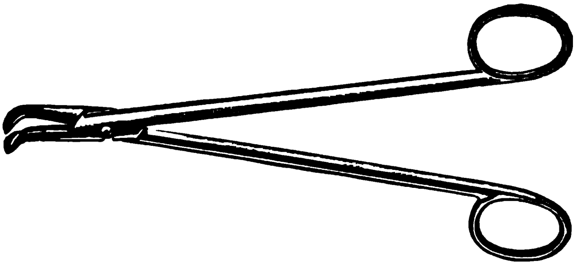
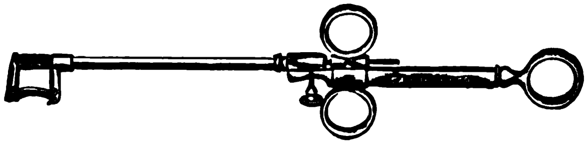


Fig. 91.



Michel-Wagener forceps and clamp.

If persistent venous oozing cannot be controlled by the above measures it is usually due to a hemorrhagic diathesis, and a transfusion or the subcutaneous injection of horse serum is indicated.

In alarming cases, in which the hemorrhage is severe, it may become necessary to ligate the common carotid artery, but such instances are exceedingly infrequent. According to Henking, in five cases of severe hemorrhage occurring after the excision of hypertrophied tonsils, the bleeding came from the posterior palatal arch, which had been incised during the operation. After the operation the patient should be kept very quiet in the house, and should be given a light diet for several days. Most so-called secondary hemorrhages are in reality merely primary operation hemorrhages, which have been allowed to continue unchecked. If the rule were always followed to have a dry tonsillar fossa before removing the patient from the table, these would be avoided. It should not be forgotten, however, that secondary hemorrhage may occur a week after the operation, so that this fact should be constantly borne in mind. A cold fluid diet should be prescribed for the first twenty-four hours. A cold gargle or spray of boric acid is very soothing, and may be used.

DEVIATION OF THE CARTILAGINOUS NASAL SEPTUM.

Deviation of the cartilaginous septum, when of recent origin, is probably due to a blow or fall, while in cases of long standing the cause is probably one of faulty development, congenital in character. The cartilaginous septum may be but slightly deflected, or the nasal passage may be so constricted that the patient can with great difficulty force any air through by an expiratory effort. As one side becomes narrowed the other one is correspondingly dilated.

Symptoms. The patient is apt to breathe with mouth open, especially at night. There is obstruction to respiration on one side, so that when the patient is requested to blow through the obstructed side, the nostril on the dilated side being closed, very little or no air will pass through. By closing the constricted nostril and repeating the same procedure a free current of air is obtained. Other symptoms are: disturbed rest at night, a nasal tone to the voice, epistaxis, and, what is of special concern to the otologist, more or less deafness, or a sense of fulness in the ear, or tinnitus, due to interference with the proper ventilation of the tympanic cavity. The nasal passage being obstructed, it is easy to understand how the drumhead becomes retracted in the act of swallowing; unless this condition is relieved at an early date serious changes are liable to occur in the drumhead, so that a permanent disturbance of hearing results. According to my experience, a very common symptom is a feeling of fulness in the ear, which is very annoying to the patient. It is usually temporarily relieved by inflation of the middle ear, but soon returns. This disease also gives rise at times to headache and reflex symptoms. A diagnosis can readily be made by inspection with a nasal speculum (Fig. 38). The deviated portion is easily seen, constricting the nasal passage, while on the other side the nasal space is unusually dilated. The latter condition will assist the surgeon in differentiating from tumors and exostoses.

Numerous operations have been proposed and performed for relieving this condition. The one that seems to me to be the most successful is the submucous resection of the deviated area.

THE SUBMUCOUS RESECTION OF THE NASAL SEPTUM.

The introduction of adrenalin and cocaine solutions has made possible another method of correcting septal deviations—the submucous resection of the deviated area.

The author believes that this procedure has entirely supplanted operations of the Asch type and operations with the nasal saw. Septal deviations in young children may be corrected by a modification of this operation, devised by Dr. J. E. MacKenty,[1] of New York (see page 221).

The author does not propose to give a detailed description of the various methods, but appends a simple account of the technique and instruments found useful in the majority of cases, and refers his readers to the standard text-books on rhinology for other methods.

The operation is usually performed under cocaine and adrenalin anæthesia, with the patient in the semi-recumbent position, and under aseptic precautions. The instruments necessary are: A nasal speculum (Bosworth or Coakley pattern), a blunt elevator (Killian model), a sharp elevator (Killian model), an angular knife (Myles pattern), for making the primary incision, a cartilage forceps (McCoy pattern), a ridge forceps (McCoy pattern), a bone forceps (Jansen-Middleton pattern), sterile cotton swabs, and cocaine and adrenalin solutions.

Anæsthesia and hæmostasis of the septum are secured by packing each side of the nares with cotton pledgets, moistened in equal parts of adrenalin, 1 to 1000, and a 10 per cent. cocaine solution. In applying these care should be taken not to have them too moist, and not to let the solution trickle into the nasopharynx and be swallowed.

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[1] New York Medical Record, November 25, 1911.

In twenty to thirty minutes anæsthesia is complete. After removal of the pledgets the sensation of the area to be removed is tested by firm pressure with a probe, and if painful the spot should be further anæsthetized by rubbing it with a swab moistened with adrenalin and dipped in powdered cocaine. Almost absolute hæmostasis is necessary for the successful performance of this operation.

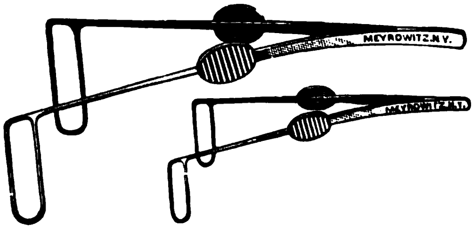
1. A curved incision is now made on the side of the convexity just behind the junction of the mucous membrane with the vestibular integument, starting on the floor of the nose and carrying it upward and forward in a curved direction. This incision should extend through the mucous membrane and perichondrium down to the cartilage.

2. The separation of the mucoperichondrial flap is accomplished by starting along the upper part of the line of this incision with the sharp elevator, and when the proper plane of cleavage is reached (between the cartilage and perichondrium) continuing it as far backward and as far downward as possible with the dull elevator. The sharp elevator is again introduced at the junction of the floor with the septum, and the separation continued backward and upward with the dull elevator. Between the two separated areas will be found an adherent line, extending upward and backward, and cor-

responding to the line of junction of the vomer with the cartilage and the plate of the ethmoid. This is now carefully separated with the sharp elevator.

3. The cartilage is now severed just behind the line of the primary incision with the cartilage knife, care being taken to leave enough cartilage in front to support the tip of the nose. If, however, in so doing, the mucous membrane of the opposite side is accidentally perforated, this incision must be abandoned and begun again somewhat posteriorly, otherwise a perforation will ensue.

FIG. 92.



Bosworth's nasal specula (two sizes).

4. In introducing the instruments through the original incision, the perichondrium is separated from the opposite side of the cartilage in a similar manner, beginning with the sharp and continuing the operation with the dull elevator over the deviated area. If this is done in a cautious manner perforation is unlikely.

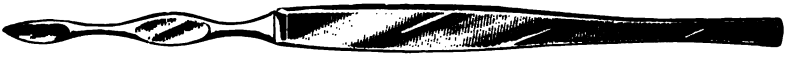
5. The deviated area, composed of the triangular cartilage, and at times of the perpendicular plate of the ethmoid and vomer, is now removed with the biting forceps. If the palatal crest is included in the deviation, it is also removed with forceps designed for that

purpose. Occasionally, bony ridges are encountered too thick to be removed with the ridge forceps. These are best removed by the judicious use of a long-handled, narrow-bladed mastoid chisel.

From time to time any oozing blood is removed with swabs, rendering visible all parts of the operative field. If the operator attempts to work in an area obscured with blood, or attempts to remove with the forceps bone or cartilage from which the perichondrium has not been completely separated, perforation usually follows.

After the deviated area has been removed, all débris and blood-clots are wiped away and the flaps carefully approximated. Each nostril is now carefully packed with small pieces of bismuth subnitrate gauze, lubricated with sterile vaseline. Care must be taken to keep the flaps in mid-line and to secure their gentle but firm approximation.

Fig. 93.

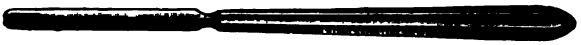


Mucous membrane and cartilage knife.

After Treatment. The patient is put to bed, and the subsequent headache controlled by the application of an ice-cap and the administration of codein by mouth. The packing of both sides is removed in twenty-four hours, and the patient instructed to remain in bed and not to blow the nose for twenty-four hours more. At the end of this time the nose is cleansed by the surgeon, and careful blowing is allowed to free the nose of its secretion.

Subsequent treatment consists of daily cleansing the nose by the surgeon, followed by the application of a 20 per cent. solution of argyrol. This is continued until the crusts, which at first are rather troublesome, have ceased to form.

FIG. 94.



Sharp mucous membrane elevator.

The dangers of the operation are: 1, shock and cocaine intoxication; 2, perforation of the septum; 3, septal hæmatoma, infection, and septal abscess; 4, sinking of the bridge of the nose, owing to a removal of too much cartilage or to a septal abscess. With the exception of the first two mentioned, these dangers are rather remote.

THE MACKENTY OPERATION. This operation aims at the removal of only sufficient cartilage and bone to allow the remainder to fit into the nasal frame without overlapping or crowding. The mucous membrane is preserved, and a perfectly straight cartilage is maintained without the necessity of splinting for more than four or five days.

Through the usual incision the mucous membrane is elevated over the side of the deformity. A strip of cartilage, one-quarter to one-third inch wide, is removed at the base, including the intermaxillary spine, but leaving the mucous membrane of the opposite side intact and *unseparated* from the cartilage above. The cartilage is now incised behind the deformity upward to the nasal bones, then forward along the upper border of the deformity to the tip of the nose. This incision goes to, but not through, the mucous membrane of the opposite side, and leaves the area of the deformity separated "en masse" from the rest of the septum and attached to it only by the mucous membrane of the opposite side and the soft tissues at the skin margin in front.

The cartilage may now be moved over to the median line, the lower margin filling in the area removed at the base.

If the cartilage still occupies two or more plains and is not in line with the septum behind, incision is made at the junction of the plains, through the cartilage, to the mucous membrane of the opposite side, and they are pushed into the median line.

The original incision is sutured, and a moulded gutta-percha splint worn on the side of the deformity four or five days. Care must be taken that the cartilage hangs freely in the mid-line and shows no tendency to revert to its former position.

If a deformity in the bony septum occurs, it may be corrected in a somewhat similar manner.

These operations offer many technical difficulties, and should not be attempted by a beginner in nasal surgery.

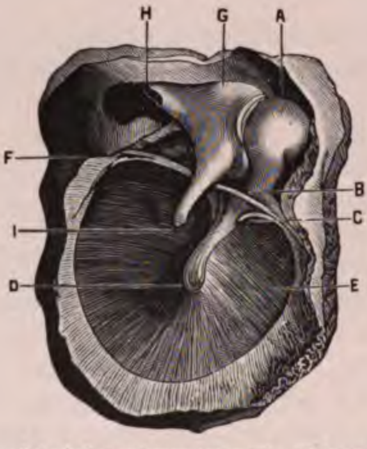
CHAPTER VIII.

OTITIS MEDIA CATARRHALIS CHRONICA, OR CHRONIC CATARRHAL OTITIS MEDIA.

THE acute form of catarrh, or frequent attacks of the subacute variety, lead to a chronic inflammation of the middle ear. In the chronic form, after exudation has occurred, adhesive processes in the middle ear are apt to develop, leading to adhesions between the drum membrane and tympanum, rigidity of the chain of ossicles, and anchylosis or fixation of the stapes.

The mucous membrane is congested and swollen from infiltration with serum. There is an increase of connective tissue which covers the incus, malleus, and attic, as well as the fenestræ ovalis and rotunda. There is more or less hypertrophy of the lining membrane of the tympanum, due to an increase of round cells and also to new connective-tissue formation. At this stage partial resolution may take place through fatty degeneration of the round cells. The tympanic cavity frequently contains thick mucus. The mobility of the ossicular chain becomes impaired, and in consequence there results more or less deafness, which may be relieved at this time by treatment, especially if adhesions have not already taken place. After cessation of the discharge the mucous membrane loses more or less of its red color, and becomes pale, although it is still thickened. The different folds of the lining membrane of the tympanum, and the ligaments which bind the ossicles together and to the walls of the middle ear, become rigid and thickened. In rare instances the mucous membrane undergoes a partial calcification. Adhesions take place between the inner wall of the middle ear and the drumhead by means of bands or striæ. The ossicles may be attached to the tympanic walls, and anchylosis may occur, so that the power of vibration of the drum membrane is seriously interfered with. The attic at times undergoes more or less obliteration from the excessive formation of connective tissue and from becoming joined with the ossicles and the inner surface of the drumhead. The conduction of the sound-waves by means of the ossicular chain becomes

Fig. 95.

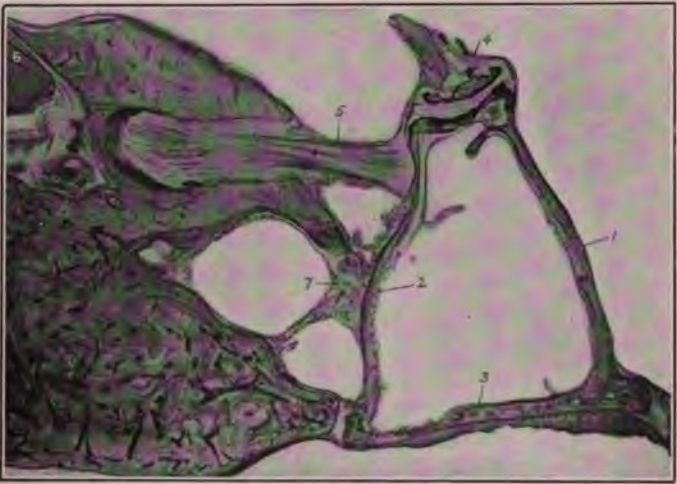


Internal surface of the left membrana tympani. (Enlarged.) (Politzer.)

A. Head of the malleus. B. Neck of the malleus. C. Tendon of the tensor tympani muscle and anterior fold of the membrana tympani. D. Inferior extremity of the handle of the malleus. E. Anterior portion of the membrana tympani. F. Posterior fold of the membrana tympani and chorda tympani. G. Incus. H. Short process of incus. I. Long process of incus.

seriously interfered with at this stage, owing to the formation of such adhesions and the occurrence of anchylosis. The three bones may be anchylosed, or there may be a separate attachment between each bone and the tympanic wall. Anchylosis between the stapes and fenestra ovalis gives rise to considerable deafness and to serious results. The edge of the foot-plate may be united with the margin of the fenestra ovalis, or the crura may be bound down by adhesive bands or striæ. Such anchylosis may follow an inflammation of the entire tympanic cavity, and be associated with more or less anchylosis of the malleus or incus, or of both of them.

FIG. 96.



Horizontal section through human stapes in foramen ovale. 1 anterior and 2 posterior crura; 3 foot plate of stapes; 4 articulation of incus with head of stapes; 5 stapedius muscle; 6 facial nerve; 7 connective-tissue adhesions (pathological.) (DIXON.)

There may be at the same time numerous striæ and bands running through the tympanum, with thickening of the membrane covering the fenestra ovalis.

Certain changes are observed frequently in the fenestra rotunda, such as thickening and calcification. The changes in the Eustachian tube depend very much on the nature of the disease in the tympanum itself. There is frequently constriction of the tube in the early stage, when the mucous membrane of the tympanic cavity is swollen and filled with round cells, and before shrinking of the tissues and sclerosis have taken place. There is usually at the same time catarrhal inflammation of the nasopharynx. It is in this stage of the disease, before adhesions have produced fixation of the ossicles and drumhead, that much benefit follows from inflation of the tympanum, and appropriate treatment of the nasopharynx and the mouths of the Eustachian tubes.

From this description of the pathological changes that are usually observed in this disease, it will be seen that *chronic catarrhal otitis media* is a term that should include cases of exudative and adhesive *catarrh*, in which there are considerable hyperæmia and swelling of the mucous membrane, followed by the formation of adhesions and anchylosis of the ossicles. It very frequently happens that the patient does not seek advice during the first stage, when the surgeon could accomplish very much by treatment, but only comes when adhesions and anchylosis have occasioned more or less deafness, which interferes with his occupation. The tinnitus at this time is often most annoying and distressing.

In this connection one must consider a disease of the *labyrinthine capsule,* called OTOSCLEROSIS, about which there is considerable difference of opinion. It was formerly called dry catarrh of the middle ear, or sclerotic catarrh. The mucous membrane of the tympanum is normal. Habermann has examined the temporal bones of a number of patients who had had otosclerosis, and he found the characteristic lesion to consist of small circumscribed points of ostitis to the number of 1, 2, 3—rarely more—which traversed the bone, the point of departure being probably about the borders of the round or oval windows. As a result of these growths the stapes becomes ankylosed in the foramen ovale, and in extreme cases there occurs a bony closure of the oval window. It is probable that in some cases there is a combination of otosclerosis and exudative or adhesive catarrh. As to the pathogenesis of this affection there are very divergent views. Heredity plays a very important part in the causation. Other causes are gout, syphilis, ozæma, the puerperal state, anæmia, neurasthenia, scrofula, and rickets. It is said to be more frequent in females than in males, and may occur in young people, especially where there is a history of heredity.

The membrana should be normal in appearance in the true type of the disease, although there may be changes, especially in elderly people. An important symptom is a congestion of the promontory seen through the membrana. Intense tinnitus is a most troublesome symptom besides deafness, which in some cases is most marked. The subjective noises may cease altogether if the deafness is entirely lost, or they may persist. Other symptoms complained of are vertigo, mental depression, a feeling of fulness in the head, and occasional sensations of pain of a tearing nature. Paracusis Willisii is frequently noted, and the loss of hearing is apt to be slight at first, and it may be years before it becomes marked. One patient may have tinnitus for some time without any deafness, while in another the tinnitus occurs some time after the deafness. When the disease affects but one ear at first it is likely to involve the other one later. The deafness may remain stationary for years or it may progress very rapidly. In order to make a diagnosis of a typical case of otosclerosis, there should be deafness or tinnitus or both, a normal drum membrane and Eustachian tube, Negative Rinné, Negative Gellé, the deep tones not heard, and, according to Politzer, "perception-limit for almost the highest tones present."

According to the writer's belief, typical cases of otosclerosis are not often seen, and these cases more often combine the symptoms of adhesive catarrh. The prognosis is particularly unfavorable in cases due to heredity or syphilis, and where the bone conduction becomes impaired and the hearing fails rapidly. The more favorable cases are those in which the disease progresses slowly and the bone conduction is good, *i. e.*, with a Negative Rinné. Inflation of the tube is contraindicated. Massage moderately and carefully applied is beneficial, but over-treatment is to be avoided. Politzer recommends sod. iodid, ½-1 gm. daily for twenty-five to thirty days, two to three times a year in cases in which the disease is not far advanced. Another remedy recommended by Siebenmann and others is phosphorus, given as follows: phosphor, 0.1, ol. jecor aselli, 100.0—one tablespoonful a day. Radium has been used with some benefit in a case reported by Richard Lake.[1]

Many of the operations on the nose for the removal of spurs, etc., besides inflation of the tubes and massage of the drumhead, only make the aural condition worse in many cases, and there is much danger of trying to do too much for a given case, where tonics and treatment of the general health would be much more to the purpose.

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[1] Transactions Ninth International Otological Congress, Boston, Mass., Aug., 1912.

There are many differences of opinion among otologists as to the pathological conditions in cases of otosclerosis, and at present not very much is known about this disease. Of nine cases examined histologically by Manasse, in four only was there anchylosis of the stapes, and in all of them there were changes in the labyrinth showing nerve deafness, so that Manasse believes that, from a clinical standpoint, the atrophic changes in the nerve apparatus are of greater importance than the changes in the bone. Mayer,[1] in a paper on Otosclerosis, believes that both the changes in the bone and the atrophic changes in the labyrinth are due to disease of the vascular system, and are not dependent one on the other.

Heredity plays an important rôle in the etiology of chronic catarrh of the middle ear, and especially in that form of circumscribed sclerotic inflammation called otosclerosis, although very often patients are unable to ascribe the disease to any such influences. Other causes are frequent attacks of acute or subacute catarrh of the middle ear, especially in childhood, chronic nasopharyngeal catarrh, diphtheria, the exanthematous diseases, tuberculosis, syphilis, Bright's disease, anæmia, pregnancy, gout and rheumatism, residence in a damp climate, sea-bathing, and the excessive use of alcohol and tobacco. Young persons and children are not so frequently affected with otosclerosis as the aged and those in middle life. The former are more frequently the subjects of the exudative variety of catarrh, which, as a rule, affects both ears.

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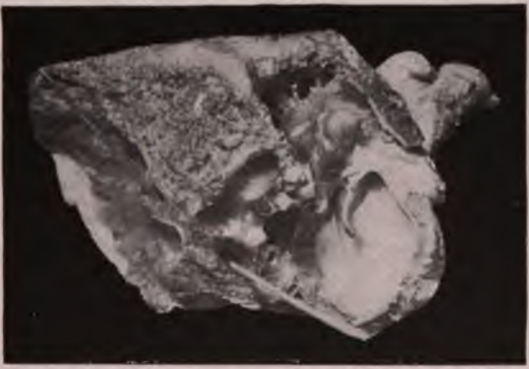
[1] Monatschr. f. Ohrenheil, 1911, Bd. xiv., Heft 4.

As chronic catarrh (exudative) of the middle ear usually is considered as an extension of catarrh from the nasopharynx, it is important, in such cases, to examine thoroughly the latter cavity as well as the nasal passages and pharynx. In some instances the patient has much difficulty in breathing through the nose with the mouth closed, owing to an hypertrophic rhinitis, the presence of a spur or polypus, or a deviated septum. In other cases the nasal passage is unusually dilated, owing to atrophic changes, and frequently at the same time the Eustachian tube is found in a similar condition. In such individuals inflation of the ear is apt to cause little if any improvement in the hearing-distance, while tests with the tuning-fork often show loss of bone-conduction. An examination of the throat in one case reveals a thickened and dull-red mucous membrane (hypertrophic); in another, the mucous membrane is unusually dry and has a glazed appearance (atrophic). Then, again, the pharyngeal wall may be studded with small elevations, with enlarged vessels leading to them (follicular pharyngitis).

Appearances of the Membrana Tympani. The membrana appears dull, lustreless, and more or less opaque. Certain portions of the drumhead may be normal in appearance, or the entire membrana may be thickened and milky white (see Fig. 97). The opacities vary greatly in shape, being semilunar at times (see Plate I., Fig. H), or there may be a peripheral or circular opacity along the lower border of the membrane, which is compared to the arcus senilis of the cornea. Chalky or calcareous deposits, often crescentic in shape, are found at times in front of the handle, although they are observed also occasionally in the posterior segment. Again, there may be chalky spots in both anterior and posterior segments, or a chalky deposit in one portion, while other parts of the membrana are opaque from thickening. The drumhead, besides being milky white or yellowish, like parchment, may assume a bluish-white appearance or even reddish-gray, the latter color being due frequently to a congested condition of the middle ear, while the drumhead is more or less transparent from atrophic changes. In some instances the membrana becomes very thin, so that the different portions of the middle ear may be clearly seen, as well as the incudo-stapedial articulation. In such a case the drumhead may be ruptured when forcible inflation of the ear is practised according to Politzer's method. The Eustachian tube is apt to be freely pervious, so that one should always be most

FIG. 97.



Section of the temporal bone, showing marked retraction and thickening of the drumhead and anchylosis of the ossicles.

cautious in forcing air into the tympanum whenever such conditions are present.

There may be atrophy of the membrane in one portion, while in another portion there is considerable thickening. On account of the retraction of the drumhead, the handle of the malleus appears foreshortened and drawn inward and upward, and especially so when the inferior extremity is adherent to the inner wall of the middle ear, while the short process stands out prominently, as well as the anterior and posterior folds of the membrana (see Fig. 100). The membrana flaccida is apt to be sunken in. There may be deep depressions in the drumhead, where the membrane is attached to the tympanic wall. In consequence of the inward and upward displacement of the long handle of the malleus, the cone of light becomes distorted and frequently very much contracted.

Symptoms. The first symptom to cause annoyance to the patient and make him seek advice, as a general rule, is a *tinnitus or subjective noise* in the ear, which, though slight at first, gradually becomes more intense, so that he is often very much disturbed by it, while in exceptional cases, where the patient is of an extremely nervous temperament and the disease has lasted for a long time, melancholia has followed. Tinnitus, on the other hand, in cases of chronic catarrh, in which there is some secretion, is usually of a transitory character or else absent altogether.

The deafness depends very much on the changes that have taken place in the drumhead, on the extent of the adhesions, and more particularly on the condition of the foramen ovale and foramen rotundum. The hearing often varies at different times of the same day, being more impaired at night, when the patient is fatigued. Change of climate, especially to a high altitude, often causes considerable improvement in the hearing as long as the patient remains there, only to be followed by loss of hearing when he returns to a damp region. Other symptoms are a sense of weight, fulness, or pressure in the head, occasional vertigo and giddiness, which may be permanent, unsteadiness in the gait, with nausea and vomiting. A patient suffering from chronic catarrh of the middle ear at times complains of pain in or about the ear, which is generally due to neuralgia, as this disease is often observed in neurasthenic subjects. Some persons are disturbed by certain sounds, particularly shrill tones, even when the degree of deafness is quite marked (hyperæsthesia acustica). The hearing of ordinary conversation, especially at a dinner or reception, when several persons are talking at the same time, is extremely difficult for a patient suffering from chronic catarrh of the middle ear. He frequently hears the higher notes, especially musical ones, extremely well, and this is often the case when the labyrinth is not affected. If, however, the latter is involved, as shown by tests made with the tuning-fork, not only will there be deafnesss for speech, but also for the watch and acoumeter, and for musical sounds, in the higher register.

The ability to hear better in a noise, more particularly in a carriage or railway train, *paracusis Willisiana*, so-called, is a symptom that frequently is noticed in this class of patients. A patient under my care could hear only very loud conversation very close to the ear, but she could understand easily every word spoken in an ordinary tone of voice when riding in a railway train. In cases in which the auditory nerve is affected without involvement of the middle ear this phenomenon is not observed. Some otologists believe this symptom to be due to an increased excitability of the auditory nerve brought about by the concussion, while another explanation (Politzer) is "that the improvement in hearing is due to the movement of the inflexible auditory ossicula, so that they are placed in a more favorable condition for the conduction of the waves of sound, and that at the same time the endings of the auditory nerve are set in vibration, producing an increased sensibility." Although this symptom is undoubtedly due to middle-ear catarrh, it may be observed in patients in whom the labyrinth is secondarily involved, for it is noted in cases in which bone conduction is normal as well as in those in which it is impaired or lost. It generally is considered as an unfavorable symptom.

When left to nature, the deafness generally increases, so that eventually the patient has great difficulty in hearing at all. Some cases progress slowly, others very rapidly. If the patient is subject to frequent head-colds, the disturbance of hearing is apt to increase rapidly, also in cases in which the labyrinth is suddenly involved, or in which the patients are suffering from some exhausting disease, such as syphilis or tuberculosis. Profound deafness is not very frequent. After steadily growing worse for a number of years, the disturbance of hearing may remain quite stationary for a time. When the disease is confined mostly to the region of the fenestra ovalis, the tinnitus is apt to be troublesome for some years before the patient really knows that he is deaf. Occasionally the deafness is limited to one ear, but this is only for a time, because when the previously normal ear becomes involved the deafness progresses very rapidly as a rule.

Diagnosis. Inspection of the drumhead reveals the existence of chalky deposits or a thickened condition of the drumhead. On the other hand, the surgeon may find atrophic changes. The membrane is more or less retracted, with prominence of the short process and of the anterior and posterior folds. The cone of light is distorted. By having the patient try the Valsalvian experiment, as well as by using Siegle's otoscope, one can observe the mobility of the drumhead. By such means the atrophic portions bulge outward when the air in the canal is exhausted, while the adherent portions remain stationary. By means of the diagnostic tube, when the ears are inflated, the permeability of the Eustachian tubes can be determined. When the labyrinth is not involved, the bone-conduction, as shown by Weber's and Rinné's tests, is better than the aërial conduction, and the higher tuning-forks are better heard by aërial conduction than the lower ones. If the disease is complicated with marked labyrinthine involvement, then the lowest tuning-forks are heard by aërial conduction, while bone-conduction is very much impaired or even lost.

The probe may also be employed to advantage in order to determine as to whether the membrana is adherent to the tympanic wall or not.

Prognosis. Much depends on the patient's general health and condition, as well as on the changes that have taken place in the middle ear and labyrinth. The prognosis is much less favorable in cases of otosclerosis, and particularly when the labyrinth is involved, than in cases in which the catarrh is of the exudative variety. When a patient seeks advice who has had a continuous subjective noise for several years, and which he likens to the sound of escaping steam, and, moreover, if the Eustachian tubes are pervious, and inflation by Politzer's method and the use of Siegle's otoscope do not produce any change for the better in the hearing-distance, the prognosis in such cases as to any permanent improvement is extremely unfavorable. Such patients are likely to be neurasthenic or hypochondriacal, and frequently inherit some tendency to deafness. The prognosis is much more favorable when the tinnitus and deafness show even a slight improvement after inflation of the middle ears. If the disturbance in hearing has come on very gradually, the chances are that the patient will not be profoundly deaf, even if he receives no treatment whatever. On the other hand, if the patient has suddenly become hard of hearing, and there is a continuous subjective noise which is not modified by treatment, and particularly if the labyrinth is secondarily involved, the probability is that the disease will advance rapidly, and the prognosis is bad, especially if the patient is suffering from some constitutional disease, such as syphilis, anæmia, or tuberculosis. A patient's occupation also has much to do with the prognosis. Gout and rheumatism play a very important part in this disease, for one meets with chronic catarrh of the middle ear very frequently in such patients. Subjective noises, which sound to the patient like escaping steam, or are pulsating in character, and which are continuous and have existed for a long time, are unfavorable symptoms. On the other hand, if the noise is intermittent, or if the surgeon is able to arrest it even for a short space of time, and at the same time cause a slight improvement in the hearing-distance, the chances of some permanent improvement are fairly good.

The question often arises as to what is the duty of the otologist under conditions just mentioned, in which the prognosis is unfavorable, namely, as to whether he should hold out any hope to the patient of improvement. It is possible for the surgeon to determine, in a very short time, whether the hearing is likely to be improved by treatment, and until the patient has been seen at least two or three times, and the middle ears have been inflated, the prognosis should be a guarded one. If at the end of this time there is any improvement in the hearing-distance or the subjective noise, the treatment should be continued. On the other hand, if there is no change whatever, the patient should be informed of the fact that treatment is not likely to be of much if any benefit; but, as the disease is likely to progress steadily, it is advisable that he should receive regular treatment for a period of six weeks at a time during the spring and fall, in order to arrest if possible the progress of the disease. He should in the intervals consult the surgeon if there is any change for the worse in the symptoms. As previously stated, many of these patients are extremely nervous in temperament, and require encouragement as well as treatment directed to their general condition. Otherwise, if told that the disease is incurable and that treatment is useless, such patients become very despondent, and the deafness is liable to become much worse. They need, therefore, some moral support, and should be under the supervision of the otologist, who should not only see them occasionally, but should also encourage them by stating that possibly by treatment the disease may be arrested. Iron and strychnine and the hypophosphites are remedies to be prescribed in many instances.

Treatment. The treatment of chronic catarrh of the middle ear should be so directed as to obtain free ventilation of the middle ear, and the restoration of the membrana tympani to its normal position if possible. Catarrh of the nasal passages and nasopharynx should receive appropriate treatment, while if there is any obstruction in the anterior nares or nasopharynx it should be removed if it interferes with the entrance of air into the middle ear. The mouths of the Eustachian tubes should be inspected, and their permeability tested by Politzer's method of inflation or by catheterization. (See chapter on Diseases of the Nose and Nasopharynx.) In the exudative form of catarrh, before adhesions have occurred, particularly if of short duration, and if attended with more or less swelling of the Eustachian tube, considerable improvement will follow the injection of air into the tympanic cavity. According to my experience, the catheter is much more efficacious for this purpose than the method of Politzer, while the improvement is more marked. The surgeon, when forcing air into the tympanum, should at first use but little force, either by Politzer's method or by the use of the catheter, for, if the tube is very dilated and the membrane flaccid, rupture of the latter may follow when too much pressure is used. In those cases in which the tubes are freely pervious, and improvement in the hearing does not follow inflation, there is no object in continuing such treatment. Instead of using air alone through the catheter, certain vapors are to be preferred, more particularly a mixture of chloric ether and iodine (Blake). This consists of: tincture of iodin. gtt. xv; chloroform., spir. vini rectif., āā ʒss. Five or six minims of this mixture should be dropped into the Politzer bag through the hole in the side, which is then covered by the thumb, and the bag is compressed. The catheter, before introduction, should be connected with the Politzer bag by means of a piece of rubber tubing at least a foot long, and then should be warmed and smeared over with sterile vaseline. It is important for the surgeon to determine, by means of the diagnostic tube, the exact condition of the Eustachian tube. When the vapor is forced into the ear, the patient usually experiences a cool and pleasant sensation. In some instances the hearing-distance is decreased immediately after this procedure, but is improved several hours afterward. When the ears are inflated by Politzer's method, and it is desirable to use the vapor just mentioned, a glass inhaler should be attached to the Politzer bag (Fig. 48). A few drops of the mixture should be poured on absorbent cotton placed in the inhaler. Some surgeons recommend to their patients the use of a large inhaler in which chloride of ammonium or other fumes are generated. After filling the nasal passages and nasopharynx with the vapor, they are directed to perform the Valsalvian experiment. The principal objection to this method is that the patient is likely to inflate the ears too frequently, and thus eventually produce a relaxed condition of the membrana tympani. Vapors of sal ammoniac, acetic acid, turpentine, the different balsams, as well as hydrogen gas and iodide of ethyl, are also used. George Stoker, of London, has used ozone in cases of chronic catarrh of the middle ear with tinnitus. He has devised an apparatus for generating the ozone and by means of a catheter it is applied directly to the middle ear every day for four or five minutes at a time for at least six weeks or longer. He claims that in cases of nasal catarrh, it reduces the hyperæmia and renders the secretion normal. Beside vapors, some otologists recommend the injection through the catheter of various solutions into the middle ear.

Politzer has seen "favorable results follow in a series of cases from the injection of five or six drops of a 2 per cent. solution of pilocarpine." The catheter is first introduced and fastened by means of a clamp. A small syringe containing the solution is warmed, and a few drops are then injected into the catheter. By means of the Politzer bag the solution is forced into the middle ear. Liquid vaseline (Ch. Delstanche) or albolene is sometimes used in the same manner as the pilocarpine solution.

Some benefit follows from the use of albolene containing 2 per cent. of pilocarpine. If a few drops only are injected into the middle ear, there is not likely to be any discomfort to the patient. As the hearing immediately after the injection is frequently made temporarily worse, it is better to vary the treatment by simply forcing air through the catheter every other time. It is occasionally advisable to treat such a patient every day for a week or ten days; but, as a general rule, it is better to inflate the ears not oftener than three times a week. The patient should discontinue treatment after six weeks' time, and have a period of rest. After the first two weeks it may be necessary to catheterize the ears but twice a week. A very mild solution of bicarbonate of soda is recommended by some otologists, and is not likely to cause much irritation of the mucous membrane of the tympanic cavity. Solutions of borax, bichloride of mercury, and iodide of potash, which are recommended by some, are contraindicated, since they are liable to cause considerable reaction.

Some authors believe that, if persisted in regularly for a long time, counter-irritation over the mastoid with iodine ointment, liniment of iodine, or blistering fluid is of value.

Randall[1] has found the use of dionin (ethyl-morphine hydrochloride), in cases of chronic catarrh of the middle ear and otosclerosis, of considerable value, and he believes that the results have been better with this remedy than with any other line of treatment. His method is to inflate the ear with a metal catheter, after gently cleansing the mouth of the Eustachian tube with sprays. One to three drops of the dionin solution (2 per cent.) are injected into the catheter, after being warmed, and then blown with a Politzer bag into the middle ear. Pneumatic massage is then gently employed, and twenty-four to seventy-two hours are allowed to pass before repeating the treatment, as Randall does not like to inject this remedy more than two or three times a week, and he discontinues treatment for a time after having injected the solution twenty times.

Some authorities claim that hypodermic injections of strychnia in the neighborhood of the mastoid process have been followed by improvement in the hearing and diminution of the tinnitus.

Good results have been claimed from the use of thiosinamin, which is derived from the volatile oil of horse-radish, or more commonly from the volatile oil of mustard-seed. The dose, according to Hare, is 4–6 grains given once a day. Sugar, of Budapest, uses it in cases of chronic otitis with adhesions and cicatrices, and in cases of sclerosis where there is connective tissue binding the oval and round windows, with ankylosis of the stapes, but where there is bony ankylosis he prefers preparations of phosphorus. He gives it hypodermically. Hirschland claims to have had good results from the administration of this remedy. In some cases the hearing has been improved, while in others the hearing has not improved, but the tinnitus has become less and the giddiness has disappeared. He says that the drug produces a redness of the drumhead and after a short time the membrane appears sodden and by catheterization one gets the impression of fluid. The improvement is not marked for the watch but for speech. He has used this remedy in a great number of cases of deafness due to chronic catarrh and in cases of suppurative otitis media where the discharge has ceased and there is a dry perforation left. He gives it hypodermically in a Pravaz syringe half filled with a 10 per cent. glycerin and water solution, and generally increases the dose. His results show that it is a useful remedy in some cases, is harmless and in a small number of cases it has rendered good service.

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[1] Transactions of the Ninth International Otological Congress, Boston, Mass., Aug. 12, 1912.

McCullagh says that thiosinamin exerts a markedly beneficial action in aural cases where there is a formation of new connective tissue. Its administration should always be combined with the usual forms of local treatment, catheter, etc. Equally good results, he claims, may be obtained from its administration by the mouth as hypodermically. A. B. Randall[1] has used it (fibrolysin) subcutaneously and has seen progressive gain under its employment. Of late he has obtained a good deal of value from its use by the stomach in the form of a new combination under the name of cirrholysin (allylsulpocarbamide = thiosinamine + bismuth iodide) which gives the iodine reaction, together with the action of thiosinamine.

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[1] Transactions of the American Otological Society, 1908.

The author has used thiosinamine in a number of cases, but has not been very favorably impressed with its value. He feels that it should be given a trial, particularly in obstinate cases.

Schwabach has used ergot in 10-drop doses three times a day for tinnitus with some good results.

Siegle's otoscope and the "rarefacteur" or "masseur" of Delstanche are useful instruments in many cases, and especially where there are recent adhesions and retraction of the drumhead. It is possible to rupture the drumhead as well as to cause ecchymoses and inflammation, if too much force is employed when the air is exhausted, so that the surgeon should always inspect the membrana while using such an instrument. In cases in which there are atrophic changes, as shown by bulging outward of certain portions of the drumhead when the ear is inflated, one should be very cautious when trying this method of treatment, for the membrane may simply be rendered more flaccid without even improving the hearing.

A massage apparatus driven by an electric motor is used by some surgeons, the object being "to exert a gymnastic influence by rhythmical oscillatory movements of the drumhead and ossicles, in order to obviate the progressive stiffness and ultimate anchylosis of those parts." Of the therapeutic value of vibratory massage of the drumhead, Schwabach states that it does but little good in cases of sclerosis of the sound-conducting apparatus. He recommends its use in cases of troublesome tinnitus, in which the patients are unable to attend to their business, in cases of simple chronic hypertrophic middle-ear catarrh with dulness and retraction of the drumhead, likewise in subacute middle-ear catarrh, also in cases of acute otitis media due to influenza, and in the sequelæ of chronic purulent otitis media, in which by the ordinary treatment no improvement in the subjective noises and hearing-distance could be obtained. In these cases the author asserts that "massage shows itself to be of essential value."

Urbantschitsch believes in the efficacy of massage of the side and back of the neck in cases of tinnitus aurium. In patients suffering from labyrinthine deafness, according to the same author, much benefit follows massage of the regions supplied by the auriculo-temporal and supra-orbital nerves. He further recommends massage of the Eustachian tube, which is effected by passing a bougie beyond the isthmus and then moving it alternately backward and forward for several seconds, and in some instances for even a minute or more. He has recently devised an electrical instrument for applying friction massage, which is worked by means of a motor. He uses celluloid bougies.

A method devised by Hommel consists in instructing the patient to press the tragus into the external meatus, and then, after removal of the finger, to allow the tragus to return to its place. In this way the air in the canal is alternately condensed and rarefied. The patient should be advised to repeat these manipulations three or four times a day, and on each occasion he should press inward the tragus about fifty times.

Lucae has devised a pressure-probe (Fig. 98), consisting of a probe with a cup-shaped cavity on the end, which is applied directly over the short process. Gentle and intermittent pressure is made on the ossicles by means of this instrument, which moves on a spring. Although considerable increase in the hearing-distance and an improvement in the tinnitus often follow its use, such improvement is not likely to be permanent. With the same object in view, various electrical instruments have been invented, by means of which vibrations are conveyed directly to the ossicular chain through a speculum constructed for the purpose. Patients are advised often by their physicians to make use of the Valsalvian method of inflation, and, as a result, there is a liability that the drumhead will become very much relaxed.

FIG. 98.

Lucae pressure-probe.

In some instances it is necessary to undertake very radical measures for the relief of tinnitus, and in a distressing case of pulsating noise, Reik,[1] of Baltimore, stopped it by ligation of the common carotid artery on the side affected. He had first ligated the internal carotid artery with partial abatement of the tinnitus, but believing that cessation of the noise had not been obtained, owing to a probable intimate anastomosis between the branches of the internal and external carotid arteries he ligated the common carotid, and a year later, when the patient returned, there had been no recurrence of the noise. In the case of an elderly person, in poor health, he did not consider it safe to ligate the common carotid, so he placed a metal band around the artery according to a method devised by Halsted, of Johns Hopkins University. A small aluminium band is passed around the exposed artery, and then, by gentle manipulation with the fingers, rolling the band so as to constrict the lumen of the vessel. Halsted's experiments prove that the operation is practically without danger if properly performed, and that the metal band becomes safely encysted. Division of the internal auditory nerve before its entrance into the internal meatus has been performed successfully in a few cases, but in most instances death has followed the operation or failure to relieve the distressing symptoms.

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[1] Transactions of the Ninth International Otological Congress, Boston, Mass., Aug. 12, 1912.

The operation of opening the semicircular canals, the vestibule, and cochlea for the relief of tinnitus and vertigo is described in another chapter.

In certain cases in which there is probably a relaxation of the tensor tympani, as well as of the malleo-incudal capsular ligament, and the corresponding attachments, such as would favor a separation of the malleo-incudal articulation, Blake employs a *rubber spring*, which he introduces into the canal, and applies directly to the neighborhood of the short process, and which acts as a support to these relaxed parts. In a paper on this subject, he reports a case of a musician whose hearing in the right ear was normal, while in the left ear there had been in childhood a suppurative process and a subsequent perforation in Shrapnell's membrane, which was dry at this time. The hearing of the left ear was about two-thirds of the normal distance. He had had a series of head-colds during the past winter, accompanied by a sense of fulness in the left ear, which had led him to practise the Valsalvian inflation frequently for the sake of the relief it afforded. Three days before his visit he had noticed, while practising on the violin, that when the head was bent forward and to the left, as is often the custom in the rendering of more delicate passages, the tones of the violin sounded dull in the left ear, and there was a definite loss of timbre perception. When the head was raised, this disability disappeared, to recur immediately on lowering the head to the position mentioned. An examination showed the membrana tympani to be intact, except that there was a small dry perforation in Shrapnell's membrane. The testimony of the patient was corroborated by tests made with tuning-forks and high musical instruments. There was considerable movement of the membrana tympani outward when the ear was inflated, such as would favor a separation of the malleo-incudal articulation "within such limits as would permit the passage of the larger sound-waves of the medium and lower tones, but would result in the loss in transit through the articulation of the motion incident to the shorter sound-waves of the qualitative overtones." Blake says "that any mechanical arrangement which would bring about a more natural adjustment of the malleo-incudal articulating surfaces, and would maintain them in that position long enough to allow the relaxed tissues to normally contract, would not only relieve the patient of his recent embarrassment, but would probably have more permanent beneficial effects." Such pressure on the short process was effected by means of a strip of thin, elastic rubber tissue 3 mm. in width and 12 mm. in length, which, being seized at the two ends with angular forceps, was carried into the ear under good illumination, with the convex portion of the resultant ellipse in contact with the short process, when, the two ends being released from the grasp of the forceps and allowed to spring outward against the walls of the canal, pressure was exerted upon the short process. With such support to the relaxed parts, it was found that the head could be placed in any position without impairment in hearing for overtones, and the patient was enabled to resume his professional work. Blake has made a change in the preparation of the rubber strip, owing to the fact that the freshly cut ends of the rubber were found to adhere under the pressure of the forceps, thus preventing the springing apart of the ends when released. The ends should, therefore, be cut, one at an angle and the other on a curve, the curved end being placed toward the posterior wall of the canal and the convex surface of the rubber strip; secondly, that portion which was to be brought into contact with the malleus was lightly smeared with vaseline before introduction. It was found that absorption of the vaseline produced a partial vacuum beneath the rubber, and resulted in so close an adherence of the latter to the skin that the beneficial effects of the spring were of much longer duration. In some cases, where there is a considerable relaxation of the membrana, Blake substitutes the *paper dressing* (see page 295).

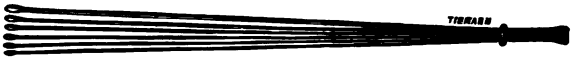
The use of the rubber strip is of benefit in cases of circulatory tinnitus marked by relaxation of the drumhead and the malleo-incudal joint, as shown by the report of such a case. The treatment must be long continued in many instances in order to get any permanent results, while the adjustment of such mechanical appliances must always be a matter of more or less experiment. A slight change in adjustment may bring about a very decided improvement.

NARROWING AND STRICTURE OF THE EUSTACHIAN TUBE.

The Eustachian tube may be constricted through swelling of the mucous membrane, or by the formation of connective tissue, which leads to contraction and stricture. The constriction of the canal is usually the result of chronic catarrh, but may be due to the pressure of a growth in the nasopharynx, and is generally situated in the cartilaginous canal, although osseous growths in the bony canal may lead to stricture of this portion. The presence of a stricture is diagnosed usually by means of the auscultation tube when Politzer's method or catheterization is attempted. Under such conditions no sound is likely to be heard, or else there is a sharp, hissing or whistling sound. There is usually considerable deafness with a distressing tinnitus, a disagreeable sensation of fulness or heaviness in the head, and occasionally dizziness.

In cases of constriction of the tube due to swelling of the mucous membrane, an attempt should be made to relieve this condition by treatment directed to the nasopharynx, and by inflation of the middle ear through the catheter. When the stricture is not overcome by such measures, bougies should be tried, and for this purpose those made of silkworm-gut, covered over with lacquer and conical in shape, are the best; or, if they have not sufficient resisting power, whalebone or celluloid (see Fig. 99) bougies, well polished, rounded, and conical shaped, should be substituted. The bougie should be dipped in liquid vaseline and inserted through a good-sized silver catheter as far as the bony portion of the Eustachian tube. A mark should be made on the bougie so that the surgeon may know the distance that it has been introduced. Care should be taken that the point of the bougie does not injure the drumhead. The instrument should be left in position five or ten minutes. In some cases Politzer uses catgut bougies that have been soaked in a solution of nitrate of silver, while in others he prefers a thin rubber capsule (that is, when the constriction is due to swelling of the mucous membrane), which is attached to the top of the catheter by a thread. By forcing air through the catheter the capsule is inflated. A small wire is also made, to which cotton can be applied, so that applications of nitrate of silver can be made directly to the mouth of the Eustachian tube through the catheter. If tinnitus or a feeling of fulness in the ear is complained of, great relief will often be experienced after this treatment. It is claimed by some that by means of electrolysis the calibre of the tube is frequently restored. As a general rule, the results obtained by the use of bougies and electrolysis are not very promising, so that they have been discarded by many otologists. In some cases the use of the bougie increases the deafness and the subjective noise, while in other cases, even after successful dilatation of the Eustachian tube, no improvement follows. Great care should be

FIG. 99.



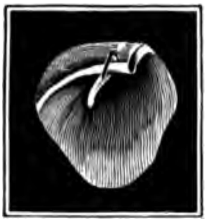
Celluloid bougies.

exercised not to lacerate the tissues when passing the bougie, for fear of inducing surgical emphysema, especially when subsequently inflating the ear. On account of this danger it is wise not to inflate the middle ear immediately after passing a bougie. In rare instances the point of the bougie has been broken off in the Eustachian tube, so that the possibility of this accident should be borne in mind.

Operative Treatment. Ever since the time of Sir Astley Cooper, various attempts have been made by surgeons to maintain a permanent opening in the drumhead, or else to excise one or more of the ossicles for the cure of the deafness and subjective noises. *It may be stated in general terms that such operations, performed for the cure of chronic catarrhal otitis media, have been unsuccessful,* although in a very few instances considerable improvement has followed. Many cases have been made *very much worse* by operative interference, and the statement made by some otologists, that the operation of excision of the ossicles will not make matters worse, even if it is not followed by some improvement, *is incorrect.* In a case which seemed to be an ideal one for the removal of the malleus and incus, as these ossicles were bound down by adhesions, the operation was not followed by any improvement to speak of, but, instead, a distressing tinnitus developed. A very nervous patient who submitted to an operation of excision of the entire drumhead, together with the malleus and incus, was assured that the deafness would not be more marked, even if no improvement followed. On recovering from the effects of the ether, the hearing was found to be much worse, and at the present time she cannot even hear with the aid of a conversation tube. The hearing-distance in the other ear also has decreased very much as a result of the operation, a phenomenon that is often observed in such cases. Numerous complications have followed the performance of excision of the drumhead and ossicles, such as purulent otitis media, mastoid empyema, burrowing abscess of the neck, etc., so that these accidents should always be borne in mind when a patient seeks advice as to the propriety of such an operation.

Cooper and others obtained brilliant results at first by making an artificial opening in the drumhead, but were obliged to abandon the operation, because the aperture soon became closed by newly formed connective tissue, and the deafness was not improved. At first, as suggested by Cooper, a portion of the drumhead was excised. This was followed by an operation devised by Wreden, in which he excised a portion of the long handle of the malleus. Later, an attempt was made by means of nitrate of silver, sulphuric acid, and the galvano-cautery, to produce a permanent opening. Such openings are apt to close very soon, and although the hearing-distance may be increased and the subjective noises lessened for the time being while there is an opening in the drumhead, nevertheless, when the latter closes, both noises and deafness may be very much worse. The object of making an artificial opening is for the relief of deafness and distressing tinnitus in cases in which the ossicles are bound down by adhesions; when the membrana is very much thickened or else contains calcareous deposits; when there is a stricture of the Eustachian tube which cannot otherwise be overcome; also in exploratory operations (to be described more fully), as well as for the purpose of mobilizing the ossicles, especially the stapes. As the object of such an operation is to allow the sound-waves to strike against the foot-plate of the stapes and reach the labyrinth immediately, it stands to reason that such an operative procedure will be unsuccessful when there is anchylosis of the stapes, or thickening and calcification of the membrane of the foramen rotundum, or implication of the labyrinth. The operation should not be considered for a moment unless there is excellent bone-conduction. Politzer has devised an eyelet of gutta-percha for insertion in the artificial opening, but it has been found impossible to keep this in place.

FIG. 100.



Handle of malleus foreshortened; anterior and posterior folds of the drumhead very prominent.

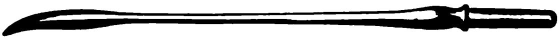
When the drumhead is very much retracted, the long handle foreshortened, and the posterior fold stands out prominently, and there is also considerable deafness with loud subjective noises, which it is impossible to relieve by other treatment, Politzer recommends *section of the posterior fold of the membrana tympani* (see Fig. 100). The incision is usually made just behind the short process, by a small knife, rounded at its point and especially adapted for the purpose.

DIVISION OF THE TENSOR TYMPANI MUSCLE.

Tenotomy of this muscle, the object being to allow the drumhead to regain its normal position, and thus relieve the increased pressure within the labyrinth, was performed first by Weber-Liel, although Hyrtl previously had suggested such an operation. In cases in which retraction of the drumhead is due to this cause alone, such an operative procedure is indicated, but, unfortunately, these instances are infrequent. One is much more likely to find not only shortening of this tendon, but also adhesions in the tympanic cavity, with a shrinking of the folds of the mucous membrane and of the ligaments.

In order to divide this tendon, an incision is first made in the drumhead either in front of or else behind the handle of the malleus, preferably in the latter position. An instrument (see Fig. 101) curved on the flat is then introduced through this opening for a distance of at least 3 mm., the tenotome being directed below the tendon of the tensor tympani. By depressing the handle so that the point of the instrument is pushed upward, the tendon is generally divided when the blade is withdrawn. The results obtained by this operation have not been successful, as a general rule, so that it has been abandoned practically, as cases have been reported where considerable increase of the deafness has followed its performance.

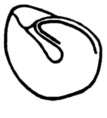
FIG. 101.



Gruber's tenotome.

Kessel, in 1871, advocated removal of the drumhead and excision of the malleus and incus, and since that time surgeons in this country and Europe have recommended different operations of a similar character, for the relief of extreme deafness, vertigo, and tinnitus aurium in cases of chronic catarrhal otitis media. Some otologists excise the incus alone, while the latest operation to attract attention has been the removal of the stapes, or *stapedectomy*. In cases of suppurative otitis media of a chronic nature, in which the malleus and incus are carious, surgeons are agreed as to the propriety of removing these bones on general surgical principles, and the benefit derived from such an operation has clearly been proved. In cases, however, of chronic non-suppurative inflammation of the middle ear, in which there is obstruction to the sound-transmission through the chain of ossicles, owing to thickening of the mucous membrane of the middle ear, adhesions, and anchylosis, *such an operation as removal of the drumhead with the malleus and incus is uncalled for if there is bony anchylosis of the stapes*. As Blake has expressed it, "the stapes holds the key to the situation," and it is undoubtedly true that in many cases which have been followed by improvement after excision of the malleus and incus, this change for the better has been due to mobilization of the stapes. Kessel further removed the columella in birds without causing disturbance of co-ordination, and demonstrated the fact that escape of the perilymph did not cause permanent impairment of hearing. Operations for the purpose of mobilizing the stapes have been advocated by different surgeons ever since Kessel, in 1875, reported a case in which he practised "circumcision" of the stapes, after dividing the tendon of the stapedius muscle. He expressed an opinion that still further improvement would have followed had the stapes been extracted and a membrane been allowed to form in the foramen ovale; which would have vibrated more readily than the stapes that had been mobilized. Blake has reported a series of cases in which he removed the stapes, the various steps in the operation being as follows: "The ear to be operated upon should be first carefully tested as to its hearing-power, both by aërial and bone-conduction, and with due reference to the possibility of sound-transmission, either by aërial or bone-conduction, to the other ear. The external auditory canal should be cleansed of cerumen and loose skin, and then washed with a weak bichloride solution on a cotton-tipped probe and stopped with antiseptic cotton until the time of the operation." The instruments used are a paracentesis needle, a small angular knife for the division of the articulation of the incus and stapes, a small blunt hook, and a pair of light but strong angular forceps, to which may be added a small rectangular knife, to be passed between the incus and the stapes, after division of the joint, and a pair of very fine, straight-tipped forceps for the removal of a portion of the bone if fractured in the attempt at extraction. The surgeon should be provided with a number of cotton-tipped probes, a bowl containing a solution of bicarbonate of soda; also vessels containing a saturated solution of boric acid in alcohol, and a 4 per cent. solution of cocaine. The instruments should be sterilized thoroughly, and the hands of the operator scrubbed and rendered aseptic. Before using the instruments they should be dipped in the alcohol and boric acid solution. If possible, the operation should be performed under conditions of local anæsthesia, so as to "permit of the conscious and undisturbed co-operation of the patient." Just before the operation a few drops of a 4 per cent. solution of cocaine are injected into the middle ear through the Eustachian catheter. The patient is placed in a high-backed chair, his head being firmly held by an assistant. An incision is then made (Fig. 102) "beginning at a point midway between the short process and the tip of the long process of the malleus and close to the manubrium, then extending upward along the posterior ligament of the short process and following the periphery to a point posteriorly on a line with the tip of the manubrium." A large flap falls downward and outward, leaving an opening which gives free access to the subsequent field of operation. Any bleeding from the edges of the cut is controlled by the application of the sterilized cocaine solution. The hearing should then be tested and the operation continued, by dividing the tendon of the stapedius muscle with the short curved knife or an angular one, "a large angular knife being subsequently passed behind the incus to insure separation." At times it is advisable to remove the incus at this step in the operation.

Fig. 102.



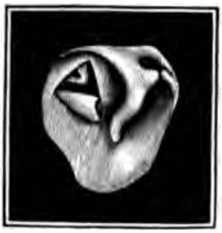
By means of a probe and blunt hook, after testing the hearing, one can then decide whether the stapes shall be mobilized mechanically by dividing the folds in the niche or by circumcision, or whether it is better to extract it. If the former has been decided upon, the region of the fenestra ovalis should be painted with cocaine, and an instrument similar to the one devised by Kessel or Politzer should then be introduced between the crura and the lower wall of the niche, and an incision made from right to left. If this is not followed by decided improvement, an attempt should be made to stretch the adhesions between the anterior and posterior crura and the walls of the niche.

Before extracting the stapes, it should be mobilized. A blunt hook, curved very slightly backward, is then passed behind the head and between the crura, either from below upward or in the opposite direction. The resistance offered when traction is made varies in different cases. At the moment of removal, however, the *pulse* often becomes *slower* in frequency, but occasionally is accelerated, and at times there is *vertigo.* Hemorrhage sometimes follows division of the stapedius muscle, but this can usually be controlled by a cotton-tipped probe. Sterilized cotton or gauze should then be inserted in the meatus and the patient kept quiet for a few days.

The results following extraction of the stapes have been decidedly *unsatisfactory,* and *the operation of stapedectomy* has generally been *condemned.* Of twenty-one cases reported by Blake, in only three was there any appreciable improvement following the operation, and in but two of them was this gain sufficient to be of material advantage. On the other hand, cases have been reported by other observers in which *alarming symptoms* followed this operation, such as *intense vertigo, facial paralysis,* and *deafness.* Before resorting to mobilization or excision of the malleus and incus, or removal of the drumhead, every other method of treatment should first be tried, while operative measures should never be considered if there is labyrinthine disease. Moreover, the surgeon should explain to the patient the possible *dangers* of any operative procedure, and he should never make promises as to any permanent improvement in either the deafness or subjective noises. If the patient clearly understands the situation, and is anxious and willing, under these circumstances, that an operation on the membrana tympani should be performed, the surgeon should first of all do an "exploratory tympanotomy," by making an incision in the drumhead exactly similar to the one already described (see Fig. 102) in the operation of stapedectomy. Thus the area of the tympanum is exposed at a point where surgical access to it is most desirable, while an incision made at this point affords a stiff flap, the edges of which can be brought together and held in position by a paper dressing until the healing, which is usually complete in three days, has been effected. The formation of a cicatrix opposite the niche in the posterior-superior segment is also avoided. Another method of exposing the articulation of the incus and stapes is shown in Fig. 103.

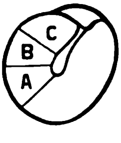
In some persons it is necessary to administer an anæsthetic; but, if possible, the operation should be done by injecting a few drops of cocaine into the middle ear through the Eustachian tube or else by the method described by Blake, as follows: "In a series of experiments on the progressive growth of the dermoid coat of the membrana tympani, made several years since, it was found that the movement outward from the centre of the membrane at the tip of the malleus toward the superior and posterior periphery was slowest in the inferior third of the posterior segment (A) (see Fig. 104), more rapid in the middle third (B), and most rapid in the upper third (C); and that the rate of movement, as shown by small pieces of paper pasted upon the membrane, bore a proportionate relation to the corresponding degree of vascularity of the three sections mentioned; while a recent series of tactile examinations shows that the sensitiveness of the posterior segment of the membrana tympani has the same relative correspondence, and therefore that an incision begun opposite the round window causes increasing pain as it is extended upward and forward along the periphery." First a preliminary incision 2 mm. in length is made close to the posterior periphery, opposite the round window, and to this a 2 per cent. solution of cocaine should be applied. After waiting a minute, the cut should be extended up-

Fig. 103.



Triangular incision in the posterior-superior quadrant for exposing the articulation of the incus and stapes. (Politzer.)

Fig. 104.



ward in the direction already described, and cocaine applied as before. By this method the incision can gradually be extended, without much if any pain, to a point opposite the centre of the posterior ligament of the short process. Tests of hearing should now be made, so that the surgeon can determine as to the advisability of further operative procedure. He may decide to divide the tendon of the tensor tympani and mobilize the malleus, or he may divide adhesions which bind the malleus and incus to the walls of the tympanum, or he may mobilize the incus or stapes, or he may conclude to excise the malleus or incus, or both of these. *Operations performed under the most favorable circumstances,* although followed by temporary improvement at times, *do not offer much hope to the patient,* if he is a sufferer from chronic non-suppurative otitis media. Surgeons generally are opposed to any radical operation on the membrana tympani or ossicula in this disease.

OTALGIA.

In this affection, an examination made with the head-mirror and speculum will show an absence of every sign of inflammation of the auditory canal or drumhead. The pain usually is referred to the ear; but it is reflex, and most frequently due to the irritation caused by the presence of decayed teeth, imperfect bridgework or inflamed tonsils. It may also arise from some laryngeal irritation.

The pain may be localized in the external or middle ear, being due to an affection of the sensory nerve or nerves supplying the ear, the most frequent causes of such neuralgia being hysteria, cold, inflammation of the nerve-trunks, and pressure on them from tumors of the brain or from caries or necrosis of the temporal bone. At times otalgia is connected with neuralgia of the fifth nerve. Neurasthenic patients and others suffering from ill health, who have chronic catarrhal otitis media, occasionally complain of pain over the mastoid process which is neuralgic in character.

Tonsillitis or peritonsillar abscess may also cause otalgia as well as a rheumatic condition of the temporo-maxillary articulation. When the disease is due to rheumatism aspirin or salol should be given.

CLICKING TINNITUS.

This is an objective form of noise which is often audible to the surgeon as well as to the patient. In some instances it can be heard a few feet from the patient, while in other cases it can be detected only with the aid of the diagnostic tube. This clicking noise, which has sometimes a metallic sound, can at times be produced at will by the patient, but it is not generally under his control. It is an infrequent form of tinnitus which may cease at times, only to return. The opinion is held by some otologists that the noise is due to spasmodic action of the tensor tympani or stapedius muscle. It is more probable that it is caused by a spasmodic contraction of one or more of the palate muscles, whereby the mouth of the Eustachian tube is opened and shut, particularly if the mucous membrane is sticky from the presence of mucus. The treatment consists in relieving the catarrhal condition and the administration of tonic remedies, especially strychnine.

CHAPTER IX.

OTITIS MEDIA PURULENTA CHRONICA, OR CHRONIC PURULENT OTITIS MEDIA, OR CHRONIC SUPPURATIVE INFLAMMATION OF THE MIDDLE EAR.

THIS disease is one of the most important ear affections that claims the attention of the otologist, and is met with very frequently among the poorer classes, owing to neglect of treatment, for there is on the part of a great many persons a strong superstition, as it were, against "checking any discharge from the ear," for fear that some serious disease will attack another part of the body. Beside, the advice is often given to patients who are suffering from this affection that they will "outgrow" the discharge, so that, as a result, the surgeon often finds great destruction of the drumhead, a carious condition of the ossicles and temporal bone, and occasionally some intracranial complication. Of two hundred and thirty-four patients suffering from chronic purulent otitis media, large granulations or polypi were found in the middle ear or external meatus in twenty-four cases, the discharge being of long duration, offensive in character, and associated with more or less caries of the ossicula and walls of the tympanum. Among the most frequent causes, beside cold and influenza, were scarlet fever, diphtheria, whooping-cough, measles, teething, meningitis, tuberculosis, nasopharyngeal catarrh, and adenoid growths.

Since scarlet fever, measles, diphtheria, and the influenza are responsible for most of the cases of acute as well as of chronic purulent otitis media, it is of the greatest importance that the ears should frequently be examined during the course of one of these diseases. Prompt and early treatment will often effect a cure. Neglect of treatment, or "letting the ears take care of themselves," results, as a rule, in chronic purulent otitis media, with caries of the ossicula and other complications.

If a free incision is not made and proper drainage from the middle ear established in a case in which muco-pus is contained within the tympanum, there is then great danger, especially in the exanthematous diseases, that the acute inflammation will become chronic. The pus, not having a free exit, forms caseous masses in the attic and antrum, leading frequently to inflammation of the mastoid cells.

Anatomical Appearances. The mucous membrane of the middle ear becomes much thickened, due to infiltration with round cells, and to enlargement of the bloodvessels and the formation of new ones. The epithelium frequently changes its character, so that, instead of being ciliated, it becomes epidermal, the epidermis extending from the external meatus into the tympanum. The mucous membrane is usually of a deep-red color, and granulations are often found on its surface, while in the deeper layers the lymphatic vessels are usually enlarged.

As a result of chronic suppuration, beside granulations and polypi that frequently develop from the mucous membrane, one notices connective-tissue bands that bind the drumhead and ossicula to the walls of the middle ear. These new formations are permanent, as a rule. In some cases there are ulcerations in the middle ear, as well as a carious condition of the ossicles and tympanic walls.

There may be a small perforation of the drumhead, or the loss of substance may be so extensive, that a mere rim of the membrana tympani remains. The drumhead may or may not be swollen or thickened, with hypertrophy of the dermal layer. There may also be calcareous deposits between the layers or an excessive development of connective tissue. After cessation of the discharge, the perforation either remains open or else is closed by thin cicatricial tissue, which frequently adheres to the wall of the middle ear. When a rim of membrane remains in the upper part of the middle-ear cavity, the long handle of the malleus usually rests against the inner tympanic wall. (See Plate I., Fig. K.) The tympanic end of the Eustachian tube is generally swollen, and the glands are enlarged, so that frequently the calibre of the tube is diminished. Occasionally, however, but very infrequently, the tube is dilated.

Symptoms. If there is a free exit for the pus, the patient does not usually complain of any pain. If, on the other hand, there is an obstruction to the escape of pus, which is due to the presence of granulations or polypi, and if there is caries of the temporal bone, not only does severe pain occur, but unpleasant symptoms also are complained of, such as oppression and a feeling of fulness in the head and ear. The pus may be prevented from escaping on account of a small perforation, or there may be inspissated masses in the tympanum. Obstruction to the escape of pus may also give rise to vertigo, nausea, vomiting, a staggering gait, great tinnitus, facial paralysis, and, in extreme cases, choked disk and retinitis. In such cases, when free drainage has been established and all granulations have been removed, these symptoms will disappear, unless the labyrinth has become involved or some intracranial complication has developed. Tinnitus is not usually so troublesome in chronic otorrhœa as in chronic catarrhal otitis media.

The deafness varies very much in the same individual, depending largely on the amount of secretion, the extent of the swelling of the mucous membrane, and also as to whether the Eustachian tube is patent or not. In some cases, especially of scarlet fever, diphtheria, typhoid fever, and syphilis, the deafness is very great. This is occasionally due to implication of the labyrinth, or to the ossicles being bound down by adhesions, or to anchylosis of the ossicula. As the mucous membrane is apt to be more swollen during damp and cold weather, the hearing is usually better when the atmosphere is warm and dry. The deafness is sometimes more marked after cessation of the discharge, a phenomenon which is probably due to the fact that the newly formed connective-tissue bands are more tense after the suppuration has ceased, since the hearing often is markedly improved when the discharge reappears and the connective tissue becomes relaxed.

Bone-conduction, as a rule, is increased in chronic otorrhœa, as shown by Weber's and Rinné's tests, except when the labyrinth is implicated.

Some writers have called attention to the fact that optic neuritis, without any evidence of an intracranial complication, is present in some cases of chronic purulent otitis media. This symptom, when found, is apt to indicate a more serious condition, and to suggest the advisability of an early mastoid operation. Gruening[1] has written an interesting paper on this subject.

Character and Amount of the Discharge. The secretion from the ear varies very much in its character and amount, being thin and watery in some cases and thick and stringy in others. At first, when the inflammation has become chronic, and before granulations or polypi have formed or the bone has become necrotic, the discharge is apt to be yellowish, laudable pus. It is usually more copious in children than in adults. In some cases in which there is a nasopharyngeal catarrh, there are long strings of mucus, which occasionally have to be removed with forceps from the meatus. These cases are often obstinate to treatment. The discharge may also be of an acrid nature, so that the external meatus and auricle are apt to be considerably excoriated.

When blood-corpuscles are mixed with the discharge, it generally denotes the presence of granulations or polypi. The discharge varies in color from a light yellow to a greenish hue. When, however, it is brownish and has a fetid odor, the chances are strongly in favor of the existence of caries or necrosis of the middle ear or antrum, or possibly of the mastoid cells. A profuse discharge is significant of mastoid inflammation.

Appearances of the External Auditory Canal and Membrana Tympani.—When the ear is examined with a head-mirror and speculum, more or less secretion will be found in the external meatus or middle ear, or crusts, due to dried secretion, will be adherent to the inner end of the canal or drumhead. When the secretion is profuse, the dermal layer of the drumhead and external auditory canal will appear macerated, on removal of which the parts beneath will have a red and glistening appearance. One notices exostoses at times on the walls of the bony auditory canal, and the calibre of the latter may be considerably diminished if granulations on its wall coalesce and form bands. In order to secure a good view of the external meatus and drumhead, it is absolutely necessary, first of all, to syringe the ear and remove all secretion and moisture by means of absorbent cotton applied on an applicator. Boric acid or bichloride of mercury should be used in the solution, or solutions containing lysol or formaline. The next step in the examination, after inspecting the external meatus, is to note carefully the condition of the drumhead, as well as the site and extent of the perforation. The latter is found most frequently in the anterior inferior quadrant, although it is observed often in the posterior superior quadrant. The perforation may be extremely small, or the entire drumhead may be destroyed, the latter condition being met with frequently in severe cases of scarlet fever and diphtheria. The hole is usually round or oval, but may be semilunar, kidney- or heart-shaped. There may be two or even three openings in the same membrana tympani, but one perforation is the rule. The kidney- or heart-shaped orifice is found generally in the lower part of the drumhead, with the long handle of the malleus dividing it in the centre. When there is considerable loss of substance, the handle of the malleus will be in contact with the inner wall of the tympanum. In cases in which the perforation is extremely small, a diagnosis can be made by having the patient try the Valsalvian method, when a small drop of pus will be seen exuding through the aperture, or, by means of the diagnostic tube, the surgeon will be able to hear a perforation-whistle when the patient inflates the ear by the Valsalvian method, or the surgeon forces air through by Politzer's method or by catheterization.

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[1] Transactions Ninth International Otological Congress, Boston, Mass., Aug. 12, 1912.

When the perforation is a large one, the middle ear appears of a deep-red color, except in tubercular cases, when it is pale. As the Eustachian tube frequently is dilated in these cases, a solution syringed into the ear may pass quite readily into the nasopharynx, hence bichloride of mercury should be used cautiously especially in children. When there is great loss of substance in the posterior half of the membrane, the incus and the incudo-malleal articulation come into view, and occasionally the foramen rotundum and the stapes in the foramen ovale. After cessation of the discharge the inner wall of the tympanum often becomes of a whitish-gray color. The drumhead, or whatever remains of it, varies in color from grayish to a dull red. When there is an unhealthy discharge the membrana appears thickened and the edges of the perforation are red and granular. After cicatrization has taken place, the margins of the orifice gradually become thinner and assume a normal appearance, and frequently become attached to the inner wall of the middle ear, in which case the hearing-power usually is decreased.

PERFORATION IN SHRAPNELL'S MEMBRANE.

A perforation in the membrana flaccida is occasionally overlooked, owing to the fact that there may be another perforation in the membrana vibrans. It is most important to remember in this connection that in about 70 per cent. of all cases there are certain folds or reduplications of mucous membrane, horizontal in position, in the upper part of the normal cavity, which interfere with the proper drainage of the tympanic attic. Beside these folds in the neighborhood of the attic, there are others irregularly placed about the round window and stapes, and still others, but principally striæ, very near the mastoid antrum. There are cases in which great congestion and swelling of these folds take place, in which all communication with the mastoid cells is cut off. An examination of such a case will reveal an otherwise normal membrana vibrans, except that there is great congestion in Shrapnell's membrane and along the handle of the malleus. Such inflammation is observed occasionally in patients who are in a debilitated condition. The pain is apt to be very severe, and follows a feeling of fulness in the ear. The proper treatment consists in a free incision along the upper border of the drumhead from the short process carried backward and sufficiently deep to divide the layer of vessels that assist in forming the inner manubrial plexus. When the patient performs the Valsalvian experiment, or the surgeon inflates the ear by Politzer's method, the air does not, as a rule, pass through a perforation in the membrana flaccida.

The danger of inflammation in this portion of the drumhead consists in the fact that there is great difficulty in draining the attic, and, as the pus is likely to decompose rapidly, the result is that caries of the ossicles is liable to follow, with more or less loss of hearing. Unless *a free incision* is made at an early date in the drum membrane, the inflammation may extend to the antrum and mastoid cells, or a carious opening may occur in the thin plate of bone forming the roof, and give rise to an epidural abscess or to a temporo-sphenoidal abscess, as happened in a case of mine, to which reference is made in the chapter on Brain Abscess. In a certain number of cases, perforation of Shrapnell's membrane is the result of a general purulent otitis media, the inflammation having ceased in the tympanic cavity, but remaining obstinate in and about the attic. The perforation may be a small one or the entire membrana flaccida may be destroyed. As a result, loss of bony substance takes place, so that a considerable portion of the attic is disclosed, Granulations or small polypi are frequently found in this region. If the discharge is checked, the movement of the ossicula is much hampered, frequently by thickening of the folds of mucous membrane and by adhesions.

The term *otitis media purulenta residua* is often applied to a case of chronic purulent inflammation of the middle ear when the discharge has been arrested and the drumhead is bound down by adhesions. The perforation may not be closed or it may be filled in with cicatricial tissue, and is frequently adherent to the inner wall of the middle ear.

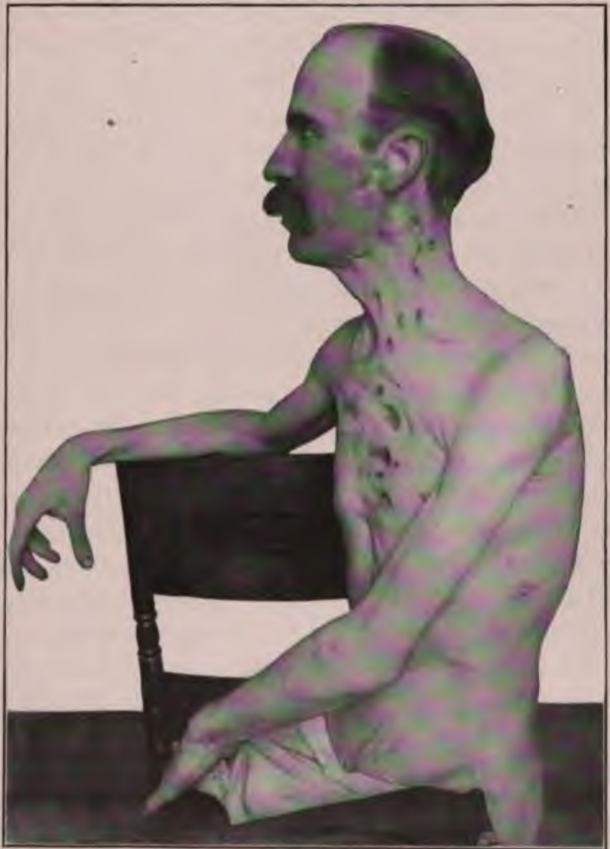
Diagnosis. In making a diagnosis of perforation, it is always important to touch with a probe the different parts of the drumhead and middle ear, not only to see if a carious spot can be found, but also, when cicatrices of the drum membrane have taken place, to determine whether there is adherence of the cicatrix to the bony wall. In this connection, Siegle's otoscope will also aid in determining this point. With the probe the surgeon can frequently decide whether there is anchylosis of the ossicles, and whether the small bones are bound down by connective-tissue bands. The disturbances of hearing are likely to be very marked in such cases, and especially when connective tissue is found about the fenestræ rotunda and ovalis. Connective-tissue bands sometimes become calcareous or ossified, in which case the degree of deafness becomes extreme.

Prognosis. The deafness, after cessation of the discharge, frequently remains stationary. In other cases the degree of deafness progresses steadily, which is due to increased rigidity of the newly developed connective tissue, or to anchylosis of the ossicles, or possibly to involvement of the labyrinth. As long as there is a discharge from the ear the patient should be impressed with the importance of having the ear properly cared for, since neglect of treatment is likely to lead to some dangerous complication. The state of the general health is especially to be considered in regard to the prognosis. The latter is much more favorable when the disease occurs in a person of good health than in one suffering from tuberculosis, syphilis, the exanthematous diseases, diphtheria, typhus and typhoid fevers.

Unfavorable symptoms are a profuse discharge of long standing, especially if it has a fetid odor, constant pain, narrowing of the external meatus, drooping of the posterior upper wall of the external auditory canal, a brownish discharge from the admixture of blood-corpuscles, the presence of cheesy masses in the discharge, and granulations and polypi.

That tubercular disease is at times a cause of chronic suppurative otitis media is clearly shown in the report of the following case (Fig. 105): The patient, a salesman, thirty-five years of age, had tubercular adenitis

FIG. 105.



After photograph of a patient suffering from chronic suppurative otitis media incidental to general tubercular adeno-osteitis.

for eleven years, the left ear discharging for about four years. Two years previous to applying at my clinic for treatment he awoke one morning to find the left side of the face paralyzed. In the interval there had been a slight improvement, and the paralysis was not so marked as when it first appeared. He had a large number of suppurative sinuses which appeared to be connected with bone. He never had any joint disease nor had he suffered from vertigo. An examination showed that the external meatus was considerably constricted, and that there was a profuse discharge. The drumhead was almost destroyed. The facial nerve had evidently been involved within the tympanic cavity.

In chronic cases the following symptoms should make one suspicious of tuberculous infection; namely, painless onset, extensive destruction of bone, often preceded by facial paralysis, large pale and flabby granulations in the external auditory canal. The perforation is usually circular with thickened, pale and indolent edges.

Eschle, in 1883, was the first to find the tubercle bacillus in the pus from the middle ear. It is likely that many cases of chronic discharge from the middle ear are tubercular, and that we should often find the bacillus in the discharge, if we looked for it in every case. Politzer believes that infection reaches the tympanum through the tubal submucosa. Henrici considers the blood path infection to be the rule in childhood, and believes the primary infection to be in the bone.

Cocks and Dwyer[1] have reported a series of thirty-two cases of children, ranging in age from ten months to fifteen years, in which they found five positive cultures, showing, according to their estimate, that 15.6 per cent. of all chronic purulent otitis media cases in childhood are tuberculous. These authors have also reported a new method for isolating and cultivating the tubercle bacillus from discharging ears and mastoid wounds.

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[1] Cocks and Dwyer: Journal of Laryngology, Rhinology and Otology, July, 1916.

A boy, aged three and a half months, was brought to me on January 5, 1916, with a history of a cold when three weeks old, probably contracted from the attending nurse. The glands were enlarged, the left ear had discharged for about three weeks and there was facial paralysis on the left side. On January 7, at the New York Eye and Ear Infirmary, under chloroform, I removed large flabby granulations from the external auditory canal and middle ear. The drumhead was not visible. The mastoid antrum was filled with granulations and softened bone. The periosteum was adherent to the bone and when separated from it some spiculæ of bone were pulled off. The bone over an area of ¾ of an inch around the antrum, above, below and behind, was roughened and congested. The bone was scraped and granulations were removed from the antrum, and the posterior superior wall of the canal was cut away, the ossicles were removed and a complete radical mastoid operation was performed. The ossicles were carious. The canal was packed with gauze, also the mastoid wound, the upper portion first being brought together with Michel clamps. The patient did very well, but the wound was slow in healing. Large glands in the neck were removed, and the child spent the summer in the Adirondacks where he improved very much in general health. There being still granulations in the middle ear and some carious bone, I reopened the mastoid wound in April, 1917, and scraped out flabby granulations and softened bone, and also removed a large sequestrum. The wound healed up and the child has gained steadily in health, while the facial paralysis, though present, is much improved. An interesting fact in connection with this case is that three babies, including this one, born in the same hospital and attended by the same nurses, all had tubercular disease of the middle ear and mastoid. There was no history of tubercular trouble in the parents of these children, and on investigation it seemed probable that one of the nurses communicated the tuberculous germ to each of the children. Experimental inoculation should be tried when the tubercle bacillus cannot be found in the pus and granulations. The question of tuberculin treatment has not as yet been settled; some think it of value in tuberculous disease of the ear while others consider it worthless.

Treatment. To treat the ear properly, it is of the first importance (1) to remove thoroughly all secretion from the tympanum and external meatus; (2) to establish as perfect drainage as possible; (3) to check the discharge and bring about cicatrization of the perforation. One should, first of all, syringe the ear with water that has previously been boiled or that contains boric acid in solution (10 grs. to ℥j), or carbolic acid (2 per cent.), permanganate of potash (5 per cent.), or aluminium acetat (2 to 3 per cent.), or lysol (1 to 2 per cent.), or formaline (20 drops to a pint of water), or bichloride of mercury (1 : 5000). The latter is indicated in all cases in which the micro-organisms are particularly virulent, especially in cases of scarlatina, diphtheria, or influenza. There is one precaution that should be taken in regard to the use of bichloride of mercury in chronic otorrhœa, which is, that great care should be used in the case of children, and also in all individuals in whom the Eustachian tube is dilated, for in such instances the solution is apt to enter the nasopharynx. It is well, therefore, in order to avoid this accident, to use but little force, and also to incline the patient's head toward the affected side. Watery or alcoholic solutions of resorcin (4 per cent.) are said to be of much value where the secretion is mucopurulent and stringy. The ear should never be syringed forcibly, for fear of causing vertigo. After all secretion has been syringed out, the external meatus and middle ear should be dried as thoroughly as possible by means of absorbent cotton on a cotton-holder. The cotton should gently be pushed down to the membrana tympani and rotated, in order to absorb the secretion. When the perforation is large, the purulent discharge can be frequently forced out of the middle ear by means of Politzer's method of inflation, or by the use of the catheter, or it can be removed through exhaustion of air by means of Siegle's otoscope with masseur attached. Another method consists in forcing a stream of water, containing common salt or boric acid (grs. x to ℥j), through the Eustachian catheter and middle ear, especially if there are accumulations of caseous or cholesteatomatous masses in the tympanic cavity. The syringe should be attached to the catheter by means of soft-rubber tubing.

When the discharge is profuse, the ear should be syringed or douched at least three or four times a day; otherwise, less often. It is difficult for a patient to syringe his own ear satisfactorily. When entrusted with a syringe, the best one is a soft-rubber bulb-syringe (Fig. 70.)

After thorough removal of all secretion, the next step in the treatment consists in the instillation of astringent solutions containing either zinc sulphate, copper sulphate, or lead acetate, three to eight grains to the ounce of water, with the addition of a drachm of glycerin, or Burow's solution may be used. The solution should always be warmed first, as cold is apt to cause pain or dizziness. When the perforation is small, the solution will frequently not enter the tympanum unless the head is held to one side and the ear is inflated by the Valsalvian or Politzer method, thus allowing the fluid to pass in when the air-bubbles escape. As thorough drainage is essential, it is much better, when the perforation is small and the discharge profuse, to enlarge the orifice by incising it. When this has been done, solutions can more thoroughly be applied to the middle ear. A solution that is especially beneficial in uncomplicated cases is one containing—

℞.	Acid. boric.,	gr. xv;
	Zinc. sulph.,	gr. viij;
	Glycerin.,	ʒj;
	Aquæ.,	℥j.—M.

The solution should be instilled into the ear several times a day. When zinc sulphate does not check the discharge, then copper or lead should be substituted. If the perforation is large, and the surgeon can see the patient frequently, the so-called dry treatment is generally much more satisfactory than the use of drops. Frequent syringing of the ear often keeps up the discharge in many cases, so that it becomes necessary to resort to the so-called dry method, which consists in the insufflation of boric acid or some other powder into the middle ear, after the secretion has first been most carefully removed by syringing and the canal dried by absorbent cotton on an applicator. Finely powdered boric acid should be blown through a speculum into the middle ear by means of a powder-blower. The powder should never be packed in, as was formerly done, for fear of preventing the escape of the pus, and thus inducing septicæmia. Besides boric acid, other powders are frequently used, such as iodoform, especially in cases of caries or syphilitic disease, or boric acid and iodoform mixed in equal parts, or equal parts of boric acid and zinc oxide, or xeroform. Iodol is sometimes substituted for iodoform, but it is not as efficient in its action. Other powders sometimes used are aristol, europhen, and orthoform. The ear should be cleansed and the powder insufflated once a day, and less frequently as the discharge becomes diminished in quantity. Occasionally, after several insufflations of powder, the discharge ceases. The dry treatment is not indicated, as a rule, when there is considerable mucus or when the perforation is small. After the canal has been filled with powder, a piece of sterile absorbent cotton should be placed in the meatus.

When granulations have formed and the mucous membrane is considerably swollen, great benefit will follow the *instillation of alcohol* into the canal. Being a stimulant as well as an antiseptic, its use is indicated particularly in cases in which the discharge contains cheesy masses. Soft granulations shrivel and frequently disappear, while the alcohol forces its way into the various bony cavities. Pure alcohol should not be used where there is acute congestion or symptoms of mastoid tenderness; as it frequently causes severe pain, it should always be diluted with water at first, and gradually increased to its full strength. The alcohol drops should be used at first two or three times a day, and less often as the discharge becomes less. It is well to combine boric acid with the alcohol in the proportion of grs. xv to ℥j. When the secretion has a bad odor, iodoform or iodol should be substituted for the boric acid. It is generally considered best not to carry out this method of treatment when caries exists.

In cases in which there is a swollen condition of the mucous membrane, nitrate of silver (grs. x–xx to water ℥j) is sometimes used to advantage. The secretion in the ear should be removed first by syringing, and then application made to the middle ear by means of cotton on an applicator. The contraindications to its use are the presence of large granulations, a small perforation of the drumhead, and caries of the temporal bone. To prevent the discoloration of the skin of the meatus which is likely to follow its use, the surgeon should make an application of a solution of iodide of potash to the walls of the canal.

A solution of argyrol (25 per cent.) may be used to advantage in some cases.

Urbantschitsch has had excellent results from the use of thigenol in the proportion of thigenol 2 to 4 parts, glycerin and alcohol 10 parts each. He claims to have cured cases of chronic otorrhœa where other methods of treatment have failed. He also combines thigenol with boric acid in the proportion of 1–10.

It is impossible, however, to tell at a first examination just what plan of treatment should be followed. After trying the dry method, a change to the instillation of astringent solutions or of alcohol will frequently bring about excellent results, and *vice versa.*

Autogenous vaccines have been used, and I have found them of benefit in some cases. Dr. Nagle,[1] of Boston, has reported seventy cases of chronic purulent otitis media treated during the previous four years by autogenous vaccines. In many of them the radical operation had been advised. Of this number, sixty have remained dry, five failed to continue treatment, two have recurred, and three are still under treatment. The writer says: "It is absolutely necessary, in order to get good results in the vaccine treatment of chronic suppurative ears, to have an active vaccine, to secure the correct dosage, and it is essential that the period of time that elapses between injections must be so regulated that the power of resistance shall be raised each time. These three important factors must all be secured by experiment. No definite rule can be given about them." The vaccine is made from pus which is forced out into the aural canal by catheterizing. The initial dose is usually one-tenth of a cubic centimeter, increasing gradually to a full cubic centimeter, and continuing with this dose if there has been marked improvement. Sometimes it is necessary to increase the dose to 2 c.c. before there is any improvement. The injections are given by Dr. Nagle in the arm, and the best results have been obtained by giving the patient injections at intervals of three or four days.

Various writers have reported favorable results from the use of vaccines, and the author feels that this form of treatment is well worth further investigation. Autogenous vaccines would seem to be the ideal method of administration and in acute cases should be used as early as possible. Stock vaccines have given good results and some otologists have been successful in the use of a mixed commercial vaccine.

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[1] Dr. Evelyn Wyman Nagle, The Vaccine Treatment of Suppurative Otitis Media, Ninth International Otological Congress, Boston, Mass., Aug. 12, 1912.

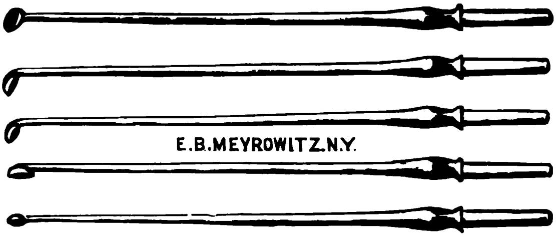
The Wick Treatment. This method consists in the introduction of a strip of boric acid or iodoform gauze, or a long, wick-shaped piece of absorbent cotton, into the external auditory canal down to the perforation in the drumhead. The gauze or cotton-wick should be changed several times during the day if saturated with discharge. It is obviously necessary to syringe away all secretion and to dry the canal and middle ear, if possible, before introducing the gauze or cotton-wick.

When granulations spring from the drum membrane or the cavity of the middle ear, which do not shrivel up under the alcohol or dry method of treatment, and especially in cases in which the mucous membrane of the tympanum is studded with numerous excrescences which give it a granular appearance, it then becomes advisable to destroy these granulations by means of caustics or by the galvano-cautery, or by scraping them away with a sharp spoon or curette.

Caustics should not be applied except in those cases in which the granulations can easily be seen, while great care should be exercised not to touch the external meatus with the caustic solution. The application of liq. ferri sesquichloridi is sufficient in some instances to cause the granulations to disappear. The solution should not be used again until the eschar has come away.

Nitrate of silver or chromic acid, fused on the end of a probe, is indicated in some cases, and particularly the acid, which penetrates more deeply into the tissues, but which causes more pain. Trichloracetic acid is also very effective. An applicator tipped with cotton should be dipped in a concentrated solution of the acid, any excess being first removed, and then applied to the granulation. Before touching a granulation with chromic or trichloracetic acid the mucous membrane should be swabbed with a 4 per cent. solution of cocaine. After cauterizing a granulation it is well to insufflate with a powder-blower some boric acid powder, xeroform, or equal parts of boracic acid and orthoform.

Fig. 106.

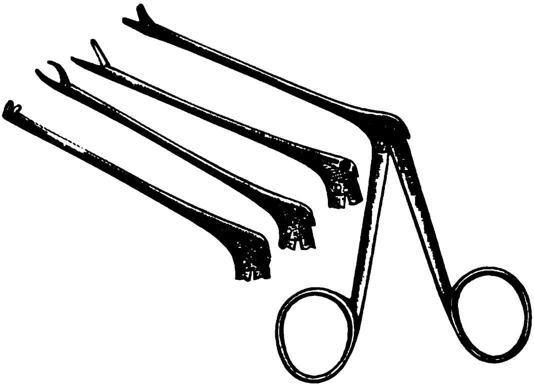


Politzer's sharp spoons.

Some surgeons prefer the galvano-cautery. It gives rise to more pain at the time of its application, but the granulations are destroyed more thoroughly, while there is usually no reaction. Scraping the granulations away with a sharp spoon (see Fig. 106) is one of the best methods, and instruments of different sizes and shapes have been devised for removing not only granulations on the drumhead or tympanic walls, but also those on the ossicles and in the attic. The cutting and punch forceps (Fig. 107) will also be found very useful. The walls, when carious, may also be scraped at the same time, a procedure which often hastens the cure.

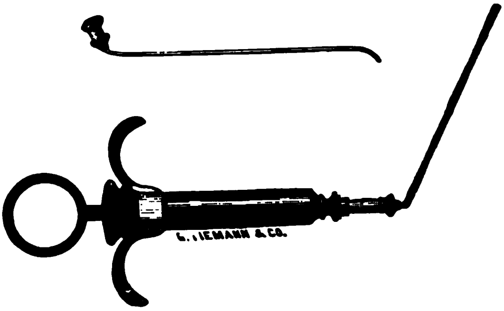
When the perforation is in Shrapnell's membrane, the first indication for treatment is to drain the attic; and if the perforation is a small one it should be enlarged, so as to enable the surgeon to wash out the attic and Prussak's space with a canula and middle-ear syringe (Fig. 108). For this purpose, a 1: 5000 bichloride solution is the best, or a solution containing carbolic acid. After thorough removal of all secretion or caseous masses, astringent solutions containing zinc, copper, or

FIG. 107.



1. Berthold's polypus scissors. 2. Hartmann's polypus forceps. 3. Hartmann's foreign body forceps. 4. Gruenwald-Citelli polypus forceps.

FIG. 108.

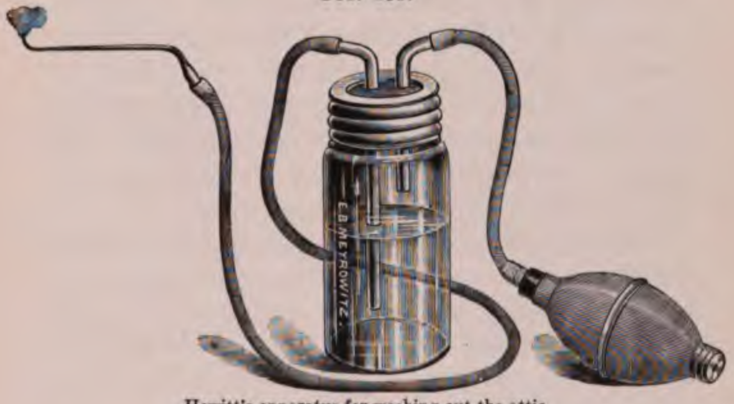


Blake's middle-ear syringe.

lead, should be injected into the attic by means of the middle-ear syringe, or alcohol and boric acid, or alcohol and iodoform, should be substituted according to the indications. Finely powdered boric acid is sometimes insufflated through a slender canula.

But little force should be used in syringing, as the patient is likely to complain of considerable vertigo. The apparatus (Fig. 109) devised by the late Dr. J. Hewitt is an admirable one for washing out the attic, and especially so after removal of the ossicles. The tubes are of glass and can readily be kept clean.

FIG. 109.


E.B. MEYROWITZ.

Hewitt's apparatus for washing out the attic.

If after several weeks' treatment by means of instillation of drops and the use of powders the discharge remains unchanged and the odor is fetid, the surgeon should then remove the carious ossicles and scrape the attic. It is in the surgical treatment of these cases, in which the suppuration is kept up by a carious condition in the upper portion of the middle ear and the antro-attic and walls of the middle ear, that one is apt to obtain very brilliant results. When the suppuration is limited to the upper portion of the tympanum, a cure can undoubtedly be effected in a certain number of cases by excision of the carious ossicles and by scraping and curetting the attic. In most instances an improvement in the hearing follows.

There are, however, a large number of cases of long-standing suppuration where removal of the ossicles does not go far enough, and where it is much better to cut down on the antrum from behind the auricle and perforate the bone with chisels and mallet. (See Schwartze-Stacke operation.) Besides excising carious ossicles, one can by this means reach the antrum much more readily, and thus remove any cholesteatomatous matter, which so often collects in this cavity.

After such an operation, viz., excision of the ossicles, the discharge does not cease at once in the majority of cases. It is usually necessary to continue the treatment previously described—namely, washing out the attic with the middle-ear syringe and using solutions and powders—before a complete cure is established.

The operation of removal of the hammer and incus is indicated not only in cases of perforation of Shrapnell's membrane, in which the secretion has persisted in spite of long-continued antiseptic treatment, but also in those cases of chronic otorrhœa in which there is but a rim of membrane left in the upper part of the tympanic cavity, and in which there is evidently some obstruction to the escape of the pus, which, becoming stagnant in the attic, causes caries of the ossicula and attic walls.

The author believes that ossiculectomy is limited to cases in which the disease is of a mild nature and confined to the attic and tympanum. When the discharge contains cholesteatomatous masses he believes that removal of the ossicles is inadequate and that the Schwartze-Stacke operation is demanded in order to prevent a possible cerebral complication.

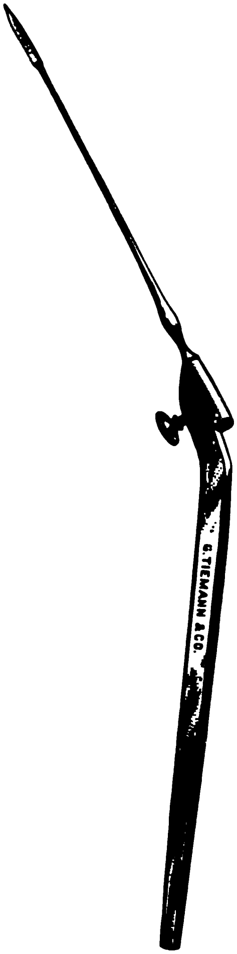
Operation of Ossiculectomy. The external auditory canal should first be syringed with a bichloride solution 1: 5000, and afterward carefully dried with absorbent cotton applied on a cotton-holder. All instruments used should be thoroughly sterilized. As the operation is a painful one, it is usually best to anæsthetize the patient, although in some adults who are not of a nervous temperament cocaine may be applied locally.

Another method of producing local anæsthesia is to inject one-quarter to one-half of a 1 per cent. solution of cocaine to which has been added ten drops of a 1 to 1000 adrenalin solution to each fluidounce. The needle is inserted in the superior wall of the external auditory canal at a point where the cartilaginous portion of the canal meets the osseous, and the solution is gently forced along the canal wall toward the middle ear.

The author prefers general anæsthesia in these cases, as he has seen alarming symptoms follow in some cases where cocaine has been used. In one case which came under his observation, in which a few drops of a 10 per cent. solution was applied to the middle ear, the patient, a woman, immediately collapsed, and her pulse became very weak, so that the operation had to be abandoned. Stimulants were administered and it was three hours before she was out of danger.

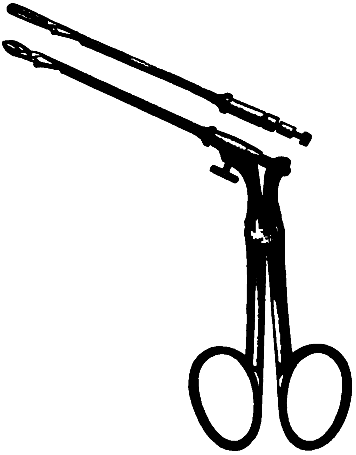
An incision should be made in the drumhead along its upper border, close to the bony wall, and the attach-

FIG. 110.



Author's knife for incising the membrana tympani and for dividing adhesions.

FIG. 111.

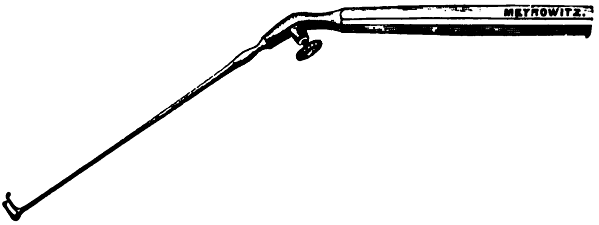


Politzer's forceps.

ments of the malleus, the ligaments, and the tensor tympani muscle carefully divided with a knife, as represented in Fig. 110. There is usually considerable hemorrhage, which impedes the progress of the operation. Syringing with hot water will frequently control this. If not, the canal should be plugged with strips of sterile gauze soaked in adrenalin solution (1–1000) and the operation suspended for a few moments. The blood should be wiped away frequently with absorbent cotton on cotton-holders, so that the surgeon can see the different steps of the operation. The head of the malleus should be disarticulated from the incus and then seized with a pair of forceps (see Fig. 111) and removed.

When there are adhesions these should be divided before attempting to extract the hammer. To remove the incus is a more difficult matter. If the long process can be seen, it should be seized with a pair of forceps, after the connection between the incus and stapes has been divided by a knife. When this is impossible, an incus-hook should be carefully introduced in the upper part of the tympanic cavity behind the incus, and the latter pulled downward and forward. An instrument that is well adapted for this purpose is the incus-hook devised by the late Dr. J. Hewitt, shown in Fig. 112. The hook is passed upward behind the incus, and then brought directly outward and downward. The incus is more apt to be carious than the malleus, and frequently the incus cannot be found. After excision of the ossicles, the attic should be curetted to remove all granulation-tissue, great care being taken not to injure the facial nerve. The external meatus should then be syringed with a bichloride solution and dried with cotton on

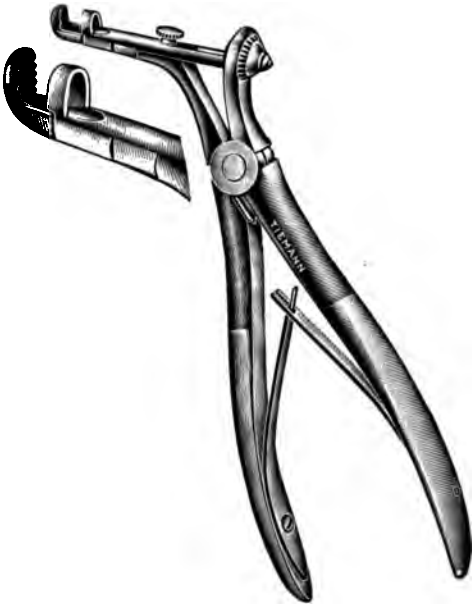
FIG. 112.



Hewitt's incus-hook.

an applicator, and then a strip of iodoform gauze should be pushed down to the middle ear and a piece of sterile cotton inserted in the meatus. A pad of gauze covered by absorbent cotton should be laid over the ear and a bandage applied. In the after-treatment alcohol drops are often used or powders insufflated,

FIG. 113.



Citelli's mastoid osteotome.

especially boric acid or aristol. The author advises great caution in curetting the attic. In cases in which, by the careful use of the probe, exposure of the dura is diagnosticated or even suspected, curettage of the attic through the external meatus is contraindicated and the Schwartze-Stacke operation should be performed.

Besides removal of the carious ossicles and scraping of the tympanic cavity, it is advisable in some cases in which there is caries of the bony wall just above and bordering on the perforation in Shrapnell's membrane, to remove the diseased bone with a sharp spoon or by means of forceps or an osteotome especially designed for this purpose. (See Fig. 113.)

ATTENTION TO THE GENERAL HEALTH.

When the discharge from the middle ear has been checked (in cases of chronic suppurative otitis media), a child previously pale and anæmic often assumes a healthy appearance, so that it is important first of all to arrest the discharge, and particularly to remove all caseous masses, which, if absorbed, may lead to tuberculosis. I have seen the health of a tuberculous patient greatly improved after the removal of softened bone and cheesy masses from the mastoid cavity. It becomes the duty of the aural surgeon not only to arrest the discharge and to improve the hearing, but also to inquire most carefully about the patient's general health. Errors of digestion should be corrected. Strumous children should be given cod-liver oil, syrup of the hypophosphites, or syrup of the iodide of iron. Many patients suffering from chronic otorrhœa are broken down in health or are sufferers from tuberculosis or syphilis. Change of climate is often desirable, especially for those afflicted with nasal catarrh.

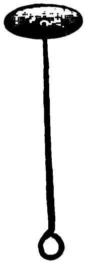
The surgeon should never fail to examine carefully the nasopharynx, especially in children, to see if there are adenoid growths or enlarged tonsils.

Proper treatment of the nares and nasopharynx is indicated in all cases whenever required, by means of sprays, by the removal of spurs on the septum, etc. (See chapter on Nasal Diseases.)

ARTIFICIAL MEMBRANA TYMPANI.

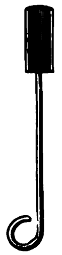
Yearsley, in 1848, recommended the application of a ball of cotton to a drumhead that had been partially destroyed, for the improvement of the hearing-distance, while in 1852, Toynbee gave to the profession the artificial drum membrane which bears his name (see Fig. 114). It consists of a round disk of thin rubber about 6 mm. in diameter, attached at the centre to a piece of wire, by means of which the artificial drum membrane can be introduced into the canal and properly applied.

Fig. 114.



Toynbee's artificial drum membrane.

Fig. 115.



Artificial membrana tympani for use in practice among the poor. (Politzer.)

Politzer has devised another form of membrane, consisting of a piece of rubber 1 cm. long, which is cut from the side of an india-rubber tube 2–3 mm. in thickness. The lower end, being perforated, is fixed to a moderately strong wire (see Fig. 115). This appliance, being inexpensive, is especially adapted for use among the poor.

A very simple device for improving the hearing consists of a piece of rubber tubing, which should be cut off to correspond to the length of the external auditory canal, and so rounded at the inner extremity as to rest against the remnant of the drumhead.

Hassenstein has invented a pair of forceps for grasping a finely rolled, wick-shaped piece of wadding.

Ch. Delstanche uses a ball or roll of cotton which has been twisted about a thin wire, and which the patient can be taught to make for himself. Toynbee's membrane is seldom used at the present day, as its application causes irritation of the external meatus and of the drumhead, and, besides, patients often complain of a disagreeable noise in the ear while talking or eating. The cotton ball or wick, on the other hand, can be used even when there is slight moisture, as this will be absorbed by the wadding. Borated cotton, or cotton soaked in astringent solutions, or smeared over with vaseline, may be used according to the condition of the middle ear.

The patient should be instructed by the surgeon to introduce the artificial membrane by means of Hassenstein's forceps, or other instruments adapted for the purpose, and he will soon become very proficient in applying the membrane to the exact spot at which the hearing is improved.

The first application of an artificial membrane may not be followed by improvement, so that the surgeon should make several attempts before deciding as to whether it is indicated or not.

Different views have been expressed by surgeons as to the mode of action of the artificial membrane, some holding that it is simply necessary to close the perforation, while others believe the improvement in hearing to be due to the pressure exerted against the remnant of the drumhead and ossicles. The latter view is probably the correct one, as improvement in the hearing often follows when pressure is made just over the stapes. The artificial membrane should be tried in all cases in which local treatment has failed to improve the hearing-distance. It should never be used in the case of children or when there is much if any discharge. It is contra-indicated when it causes irritation or inflammation or dizziness.

As the artificial drum membrane is liable to cause a certain amount of irritation, it should be applied and left *in situ* for an hour or so at first, and the time gradually increased each day. The cotton should be changed as often as it becomes saturated with discharge; in such cases the ear should be syringed and dried before it is reapplied. After the patient has learned the mode of application of the membrane he will be able to change it frequently himself. It is often advisable for him to do this each day.

A patient was sent to me a short time ago, suffering from vertigo and symptoms suggestive of an intracranial complication. On examining the ears I removed an artificial ear-drum, such as is usually advertised in the daily papers, from each ear. The patient had a chronic otorrhœa, and the retained secretion in the middle ears had caused all the symptoms. As the patient heard very well with these aids to hearing, she was very loath to have them removed. In two days after they had been taken out, so that the pus could escape from the canals, all unfavorable symptoms had disappeared.

In a case of perforation of the drumhead, cicatrization of the same may at times be brought about by touching the edges with nitrate of silver fused on the end of a probe, or by scarification of the drum membrane, while incisions made near the opening occasionally produce a similar result. Another procedure (Blake) consists in the application of a disk of paper a little larger than the perforation to be covered. Ordinary writing-paper is used for this purpose, because (1) any desired thickness can easily be procured, and (2) the sizing used in finishing the paper when moistened is sticky enough to make the paper adhere to the membrana tympani. Such a disk is best introduced by means of a probe tipped with cotton and dipped in water, so that the paper adheres to the moistened cotton until it comes in contact with the membrana tympani. The disk of paper should then be pressed firmly into position by a cotton-holder tipped with dry cotton. The paper dressing is useful in only a limited number of cases, viz., those in which the perforation is small, and the inflammation has subsided, and there has been cessation of the discharge, the external surface of the drumhead having resumed a normal condition. It may also be applied to advantage in cases of rupture or mechanical injury, the paper dressing keeping the edges of the wound in apposition. Such a disk of paper will remain *in situ* until either the perforation (a small one) becomes closed, or until slight discharge from an inflammatory process washes it away.

I have lately had marked success in closing even large perforations by cauterizing the edges with a concentrated solution of trichloracetic acid, as advocated by Okuneff, Gomperz, Politzer, and others. A piece of cotton soaked in a 4 per cent. solution of cocaine is inserted in the perforation and allowed to remain for ten minutes. A cotton carrier, with a small piece of absorbent cotton wrapped around the end, is then dipped in the acid, and any excess removed by means of dry cotton. The edges of the perforation are touched with the acid and a white eschar is seen to form. Boracic acid powder is then insufflated. According to Gomperz, the "cauterizations should be repeated at intervals of from four to eight days; the number of applications varies according to the size of the perforation, and is generally from three to fifteen." The following case shows what can be accomplished by this method, although the treatment extended over several months. The patient, thirty years of age, accidentally punctured her drum membrane with a hairpin. When she came to me she had acute suppurative otitis media. The discharge was arrested by the insufflation of powders but there remained a large perforation involving the posterior inferior quadrant of the drumhead. As the perforation did not show any tendency to heal under the use of silver nitrate or the paper disk, I made applications of trichloracetic acid, but not until six months after I first saw the patient was the perforation closed with new tissue which was partly adherent to the inner wall of the middle ear. The tinnitus, which had been troublesome, disappeared and the patient could hear a low-pitched voice at a distance of twenty feet and a whisper at twelve feet.

Milligan recommends, in order to close a perforation, the application of a small disk of salicylic acid plaster to the perforation, which sets up a certain amount of local irritation.

In cases in which the defect in hearing seems to be dependent on a relaxed cicatrix, as shown by increased impairment of hearing when the cicatrix bulges out, and by an improvement when it returns to its position, an attempt is sometimes made to bring about contraction of this relaxed tissue by means of multiple incisions made in the cicatrix with a fine needle, or by painting it with collodion.

There is usually more or less disturbance of hearing not only during the course of the suppuration, but also after cicatrization has taken place. Improvement of hearing follows in some cases from the use of Siegle's otoscope, especially when the deafness is dependent on adhesions that can be broken up by the rarefaction or condensation of air in the external meatus. The pressure probe (Lucae) is useful in other cases, although the improvement in hearing, that at times is very marked, does not, as a rule, continue. The probe consists of a cup-shaped disk, which is attached to a long handle, and which works on a spring. The disk is placed usually on the short process, and intermittent pressure is made by means of the spring.

DIVISION OF ADHESIONS. EXCISION OF OSSICLES.

As the result of adhesions due to chronic purulent otitis media, permanent disturbances of hearing remain; also, occasionally, distressing tinnitus or vertigo unless relieved by an operation.

The ossicles may be so bound together and to each other that nothing but a radical operation will afford any relief. No definite promise should be made to the patient as to any permanent improvement in the hearing or the tinnitus or vertigo, but it may be stated, as a rule, that when the bone-conduction is better than the aërial conduction, and the ossicles are bound down by adhesions as a result of chronic suppurative otitis media, the hearing is generally improved by an operation. The nature of the adhesions should first be determined by means of Siegle's otoscope and a probe. With a suitable knife, band-like formations between the handle of the malleus and the incus and stapes should be divided, as well as adhesive bands between the ossicles and tympanic walls. In some cases the hearing shows a permanent improvement, while in others it is but temporary. If division of adhesions and mobilization of the stapes are followed only by a temporarily improved condition, and the patient is willing to undergo a further operation, then the malleus and incus should be excised. The different steps in this operation have already been described (see pages 287, 288 and 289).

CHOLESTEATOMA AND EPITHELIAL MASSES IN THE TYMPANIC CAVITY.

During the course of chronic suppurative otitis media there are found at times in the secretion masses of epithelial cells, not only in the external meatus, but also in the middle ear. The patient may not suffer any particular discomfort, and these epithelial scales may be found in the discharge for years. If, however, there is any hinderance to escape of the pus, these masses often form a large plug and give rise to considerable pain and pressure symptoms, such as vertigo and vomiting. If not removed, they lead to ulceration of the bone or to an intracranial complication. When the disease is limited to the attic, there being a small perforation in Shrapnell's membrane, caries of the ossicula is apt to occur, or the disease is likely to extend to the brain through the tympanic roof.

The term cholesteatoma is applied generally to a collection of epithelial cells, round or polygonal, arranged in concentric layers, and mixed with fat-globules and crystals of cholesterin. Sometimes the whole mass is covered by a pearly, shining membrane.

There is a great difference of opinion among pathologists as to the origin of these masses, some maintaining that a cholesteatoma in the temporal bone is of heteroplastic formation, while others consider it to be a retentive tumor. Still others believe these scales to be formed in the external meatus and to extend through a perforation into the middle ear and antrum. As opposed to this latter view, it may be stated that a case of cholesteatoma of the tympanum has been reported without any evidence of suppuration of the middle ear or perforation of the drum membrane. Such cases are extremely infrequent, however, as cholesteatoma is observed usually in cases of chronic suppurative otitis media.

A cholesteatoma may be found in the middle ear, antrum, or mastoid cells, the latter being the most frequent seat of the disease. In some cases the cholesteatoma is of small size, while in others it is very large, leading to more or less destruction of bone from pressure and absorption, or there may be extensive caries. The middle ear, antrum, and mastoid are sometimes transformed into one large cavity, or there may be considerable destruction of the margo tympani or of the posterior and superior bony walls of the external meatus.

Symptoms. The symptoms vary according to the size and nature of the collection of scales. There is generally a feeling of fulness or heaviness, or there may be pain, headache, and vertigo. The cholesteatomatous masses may either escape through the perforation, or they may extend to the antrum and mastoid cells, and lead to mastoid disease or some intracranial complication, so that an operation becomes necessary. The pus not being able to escape, may give rise, through absorption, to septicæmia or pyæmia, or meningitis may follow, or cerebral abscess, or sinus phlebitis, or suppurative labyrinthitis, or severe hemorrhage from erosion of the lateral sinus or carotid artery.

Diagnosis. It is very important to make an early diagnosis of cholesteatoma, as the disease is a destructive one, and radical treatment is required at an early date if the surgeon expects to cure the discharge. The diagnosis can only be made with certainty when the epithelial cells either in the external meatus or protruding from a perforation in the drumhead, are examined under the microscope. Fistulous openings occur in the bony meatus in some cases. When there is a considerable discharge of epithelial scales from the middle ear, associated with pain in the mastoid process, it is probable that the latter is involved, and an immediate operation is indicated.

Treatment. If there is a large opening in the drum membrane and the cholesteatomatous masses are not excessive, an attempt should be made at first to wash out the tympanum with a bichloride solution by means of the middle-ear syringe (see Figs. 108 and 109). When the perforation is small and is in Shrapnell's membrane, it should be enlarged and the attic irrigated in the same manner. This plan of treatment should not be continued for a long time unless a decided improvement ensues, on account of the complications likely to develop.

If the patient complains of pain or dizziness, and the cholesteatoma is in the antrum or mastoid process, the operation of opening the antrum and cells should be performed at once (see chapter on Mastoid Diseases), so that the cholesteatomatous masses can be reached and scraped away with curettes. The inner wall of the tympanum should be carefully examined for a sinus leading to the semicircular canals or the cochlea. If the ossicles are found carious, they should be excised and the attic curetted, great care being taken not to injure the facial nerve. In certain cases, when the disease is limited to the middle ear, attic, and antrum, the Schwartze-Stacke operation is indicated. This operation is described in the chapter on Mastoid Diseases.

CHAPTER X.

GRANULATIONS AND POLYPI—CARIES AND NECROSIS OF THE TEMPORAL BONE.

GRANULATIONS AND POLYPI.

GRANULATIONS should be considered under the same classification as polypi, for they are observed generally in connection with chronic otorrhœa, and, beside, a granulation may develop into a polypus. Occasionally, granulations as well as polypi appear during the course of an acute purulent otitis media; but, as a rule, they are the result of long-continued suppuration from the middle ear, with or without caries. Large flabby granulations frequently conceal a carious spot either in the bony auditory canal or in the tympanic cavity, or a carious ossicle may be embedded in granulation-tissue. Polypi are attached generally to the mucous membrane of the tympanum, less frequently to the wall of the external meatus and to the membrana tympani. Cases have been reported in which polypi were found in the tympanic cavity without perforation, but such instances are extremely infrequent. When attached to the external meatus, the most frequent site is the posterior superior wall of the bony canal close to the membrana tympani. The importance of examining microscopically every growth removed from the external auditory canal or middle ear is demonstrated in the report of the following case:[1] A woman, fifty years old, came to my clinic, complaining of slight tinnitus and deafness. An examination showed a tumor apparently filling the external meatus and attached by a pedicle to the posterior cartilaginous canal wall. There was no involvement of the middle ear. It was removed with a Blake snare, and perfect healing followed. The microscopical examination showed it to be a sarcoma.

There may be a perforation in Shrapnell's membrane with a polypus protruding through the opening. Polypi are found simultaneously in the middle ear, on the drumhead, and in the external auditory canal. They vary greatly in size, being at times extremely small, or sufficiently large to fill the external auditory canal and to protrude from it. The external meatus is liable to be enlarged by the pressure of the growth. A polypus may be attached by a slender pedicle or by a broad base. There may be but a single one, or there may be several. They vary in shape, being either smooth and club-shaped, or they resemble a raspberry, and have a knobbed and glandular appearance. They are bright red frequently, but when exposed to the air they generally lose their color and become pale and pinkish.

Four varieties of polypi usually are described, viz.:

1. Mucous polypi.
2. Fibromata.
3. Myxomata.
4. Angiomata.

The most frequent varieties are the mucous polypi and fibromata. Myxomata are very rare.

1. *Mucous polypi* are more frequently observed than

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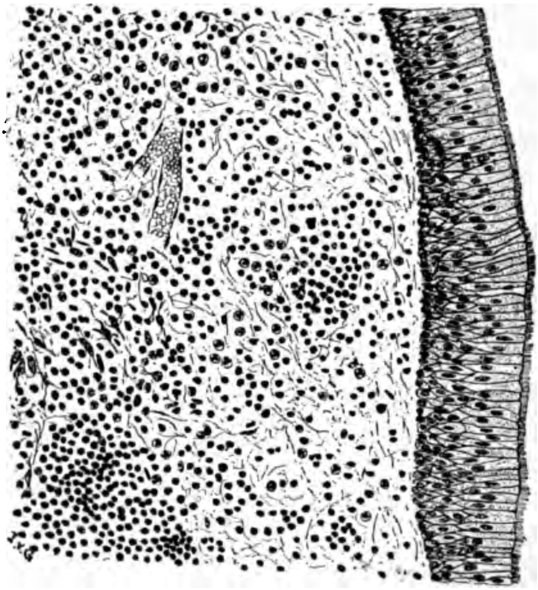
[1] Report of New York Otological Society, Archives of Otology, vol. xxix. No. 1. 1900.

any of the others, and histologically are identical with polypi found in the nares and nasopharynx. They are formed of a delicate and loose stroma of areolar connective tissue, in which are enclosed round-cells and occasionally a few spindle-shaped cells. These polypi contain numerous bloodvessels, and generally have an irregular surface, due to their papillary and glandular structure. Cysts, considered by some authors as retention-cysts, are found in these polypi. The epithelium on the inner surface is usually of the cylindrical or ciliated cylindrical variety, while that covering the surface exposed to the outer air is pavement epithelium.

FIG. 116.



Section of mucous polypus.

A soft or mucous polypus may gradually become transformed into a fibroma by the bloodvessels becoming obliterated and by the cellular elements becoming changed into spindle-cells and connective-tissue fibres.

2. *Fibromata.* A fibroma is covered with pavement epithelium, and is composed of connective tissue with spindle-cells interspersed in its meshes. It has fewer bloodvessels than a mucous polypus, and in consequence is paler in color and does not bleed so readily when touched with a probe. It is of a firm consistency, but does not contain cysts and tubular glands. It is usually attached to the periosteal lining of the tympanum or external meatus, and its growth is much slower than that of a mucous polypus.

3. *Myxomata.* Myxomata are observed very infrequently. Histologically, the tumor consists of a multiple layer of pavement epithelium for its external covering, into which flat papillæ project. The stroma is of a homogeneous gelatinous tissue, and contains spindle and star-shaped cells. There are also round glandular cells with a round nucleus similar to lymph-corpuscles.

4. *Angiomata.* These polypi are very vascular, and consist of a network of blood-spaces which appear to take the place of capillaries. The blood enters these spaces directly from the arteries, and thence goes to the veins and thence into the general circulation. When examined under a microscope, the growth is found to consist of bloodvessels connected with a large and irregular central cavity containing fibrous connective tissue.

Although a polypus in the external meatus, as a rule, has its attachment to the osseous wall, it occasionally happens that a large polypus springs from the cartilaginous canal, especially if there is a sinus at that point leading to carious bone.

A granulation or polypus often develops in the auditory canal from a point where a furuncle has existed. A polypus sometimes contains osseous deposits.

Symptoms. When granulations or polypi do not interfere with drainage from the middle ear, there may be no other symptoms except a little bloody discharge. On the other hand, if a polypus prevents the pus from escaping, the patient is apt to complain of a sensation of pressure and heaviness in the head, dizziness and tinnitus, nausea, vomiting, and even epileptiform symptoms. In extreme cases, paralysis of one side of the body and anæsthesia of the extremities are due to the presence of polypi. The secretion, being forced back into the antrum, may become stagnant, so that cheesy masses are formed, the result being caries and necrosis, or mastoid disease, and possibly an intracranial complication. In the report[1] of a case of chronic purulent otitis media occurring in a man, twenty-four years of age, the symptoms complained of were nausea, vomiting, unsteadiness in gait, and marked deafness. There was facial paralysis of one side, and both auditory canals were filled with granulations. After removal of all granulations and polypi, so that there was free drainage from each ear, there was a marked improvement in the patient's general health, appetite, etc., a decided change for the better in the hearing, and a disappearance of the vertigo and unsteadiness in gait. The facial paralysis eventually disappeared. Occasionally, but very infrequently, a polypus disappears through spontaneous shrivelling. Polypi sometimes come away in the discharge spontaneously as a result of the growth becoming turned on its axis and the blood-supply being interfered with. Sometimes granulations coalesce, leading to constriction of the meatus and retention of secretion.

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[1] Bacon: Archives of Otology, March, 1884, vol. xiii. No. 1.

Diagnosis. In order to make a diagnosis of a granulation or polypus, it is first of all necessary to remove the secretion by syringing. Then the canal should be dried by means of absorbent cotton on an applicator. The surgeon should be careful to distinguish a granulation or polypus from a bulging drumhead from which the dermal layer has come away, or from an exostosis or a malignant growth (epithelioma or sarcoma.) With good illumination and a probe, one can distinguish an exostosis by its being very hard and immovable, and frequently very sensitive to the touch.

An atheroma or sebaceous tumor of the external meatus, although of very infrequent occurrence, might be mistaken for a polypus. In order to decide the point of attachment of a polypus, the probe should be passed around the growth. A large granulation or polypus projecting from the external auditory canal has at times the appearance of a furuncle, but a probe introduced into the canal and passed around the growth will aid one in making a diagnosis.

Where the growth is malignant a diagnosis can only be made with certainty when a section of the tumor has been examined under the microscope. One of the most marked symptoms, however, is pain, which is usually very severe.

A case of aneurism of the carotid artery, appearing as a polypus in the middle ear and followed by profuse hemorrhage when incised, has been reported by Schulte[1].

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[1] Monatschr. f. Ohrenheil., March, 1904.

It occurred in a patient, twenty-eight years of age, who had suffered from a chronic otorrhœa for some time. Recently a similar case came to my attention at the Vanderbilt clinic.

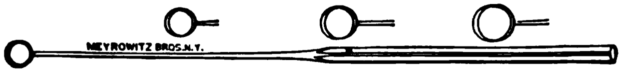
Prognosis. The prognosis depends very much as to whether the polypus is attached to the external meatus or tympanic cavity, and also as to whether there is caries of the ossicles and bony walls of the external meatus and middle ear. It is frequently difficult, even with a probe, to determine the point of attachment of a polypus, and in some cases this cannot be ascertained until at least a portion of the growth has been removed. Cases are much more favorable for treatment where the polypus is attached to the external meatus, unless associated with caries of the bony wall.

It is stated by some authors that the appearance of the tumor will aid one in determining the point of its origin, viz., that a red raspberry-like tumor with an irregular surface springs from the middle ear, but a smooth and pale growth has its point of attachment to the external auditory canal.

Treatment. The treatment of granulations is best accomplished by means of (1) curettes, sharp spoons or cutting forceps; (2) caustic applications; (3) galvano-cautery; (4) astringent solutions and alcoholic drops.

The speediest and most satisfactory method of removing granulations from the middle ear or external meatus is by means of curettes, sharp spoons, or the so-called ring-knife. The canal should first be cleansed of all secretion and dried, and then a few drops of a 4 per cent. solution of cocaine instilled warm into the ear. After a few moments the canal should again be dried and the granulations carefully removed. Great caution should always be taken when using cocaine for cases of collapse occur every now and then from instilling a few drops of cocaine into the middle ear. Some patients are particularly susceptible to its action. In the case of children, it is usually advisable to administer ether or chloroform, as it is next to impossible to keep the head still during the required manipulation. Sharp spoons (see Fig. 106) of different sizes and shapes can all be fitted in the handle for the purpose of removing granulations on the tympanic walls, the external meatus, or the drumhead. Sharp curettes (Fig. 117), of which there are three sizes, as well as the ring-knife of Politzer, are better adapted to certain cases. The latter instrument can be slipped over a granulation, especially when it is attached to the wall of the external meatus. The knife is then withdrawn quickly, by which means the growth is excised and comes away on the concave surface of the ring. There are two sizes of the ring-knife, the larger one being 3 to 3½ mm. in diameter, while the smaller one is from 1½ to 2 mm.

Fig. 117.



Sharp curettes.

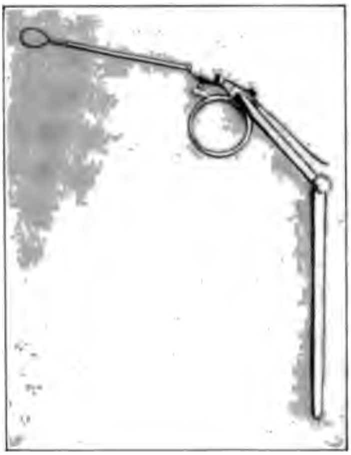
After removal of the granulations, it is further necessary to cauterize the root or base with nitrate of silver or chromic acid, or to instil into the ear alcohol drops, the latter, however, being contraindicated when there is caries or necrosis. In patients of a nervous temperament, it is frequently impossible to scrape away the growth by means of instruments. In such cases the application of caustics should be tried. For this purpose various remedies have been proposed. For small granulations, a drop of tincture of chloride of iron should be applied to the growth, or the latter should be touched with nitrate of silver fused on the end of a probe, the instrument being first heated red-hot in an alcohol lamp, and then dipped into powdered nitrate of silver. This plan of treatment is especially advisable when small granulations are attached to the middle-ear cavity or the drum membrane. Chromic acid is a much better caustic, as it penetrates more deeply into the tissues than nitrate of silver. A probe should be heated and plunged into powdered chromic acid. It is important, however, that this acid should only be applied to the polypus, and that care be exercised not to touch the drumhead or wall of the external meatus, otherwise severe inflammation is apt to follow. The polypus should not be cauterized a second time until the slough has come away. If the acid occasions much pain, the polypus should be swabbed with cotton soaked in boric acid solution, and afterward dried. It is often advisable to blow into the ear a small amount of boric acid powder after the cauterization.

Galvano-cautery. The galvano-cautery is occasionally useful in the removal of large granulations.

The use of alcoholic drops has been described in Chapter IX. These may be employed with excellent results in the case of small granulations, especially when they are soft and flabby. In some cases great benefit follows the insufflation of equal parts of zinc oxide and boric acid powder, or of xeroform, or other powders previously mentioned. The same powders are often used after granulations have been excised with

Treatment of Polypi. Whenever a polypus is large, and particularly if it has a pedicle, the best method of removing it is by means of Blake's snare. The instrument (Fig. 118) consists of a metal canula through which a loop of wire is drawn. Instead of having both ends of the wire fastened to a slide-ring, as formerly, there is substituted a cleat, around which one end of the wire should be fastened securely ; on the side of the shaft is a similar cleat to secure the other end of the wire. When fastened in this manner, it is evident that by making traction on the slide-ring the wire loop in process of withdrawal through the canal will, instead of merely constricting the growth, have a distinct cutting motion which will greatly facilitate removal of the more resisting polypi. Both ends of the wire may, however, be fastened to the cleat on the slide-ring if the

FIG. 118.



Blake's polypus snare.

surgeon so desires. The finest malleable iron wire or a very fine silver or brass wire should be used. The instrument, moreover, is so constructed that the handle, slide-ring, and canula can be removed, and the shaft made available as a handle for a paracentesis knife or for curettes or sharp spoons. There is also a small canula which is particularly adapted to excising small polypi in the tympanum. Before attempting to snare a polypus, the canal should be syringed with a bichloride solution, 1 : 5000, to remove all secretion, and then thoroughly dried. Cocaine solution, 4 per cent., should then be instilled warm into the ear, and after a few moments the surgeon should make out with the probe the point of attachment of the polypus. It requires practice and skill to apply the loop of wire about the growth. The removal of the latter may be followed by considerable hemorrhage, which can be controlled by tamponing the canal with styptic cotton, or a strip of gauze soaked in adrenalin solution (1–1000). After the larger portion of the growth has been excised in this way the surgeon will be better able to make out the point of its attachment, the condition of the tympanic cavity, and also as to whether there are other polypi.

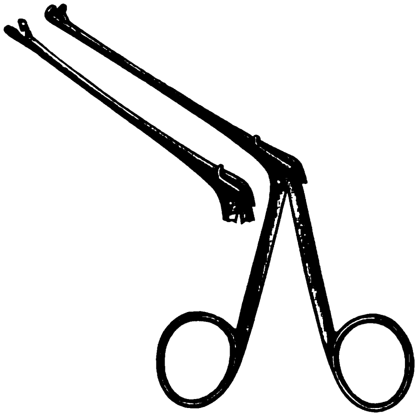
When a polypus is found protruding from a small perforation in the drumhead, it is often advisable to enlarge the opening before making an attempt to excise the tumor.

Curved scissors will be found useful for snipping off a polypus growing from the external meatus, and various punch forceps have been devised and are excellent instruments for removing the pedicle of a polypus or small granulations found in the canal or tympanic cavity

(Figs. 119 and 120). After snaring off the polypus, the root should be cauterized with chromic acid or nitrate of silver, and a strip of iodoform or boric acid gauze should be pushed down to the tympanic cavity. Repeated cauterization should be performed until the growth is entirely destroyed, and in the meantime any discharge from the ear should be treated as described in Chapter IX.

Beside astringents and powders, which may be used in some cases after removal of the growth, the *alcohol treatment* is often indicated. This method is useful not only for the purpose of shrivelling up the roots of the polypi and granulations on the membrana tympani and in the external auditory canal, but also in those cases in which the polypi are situated in the tympanic cavity, and in cases of exostosis of the external meatus where the growth cannot easily be reached.

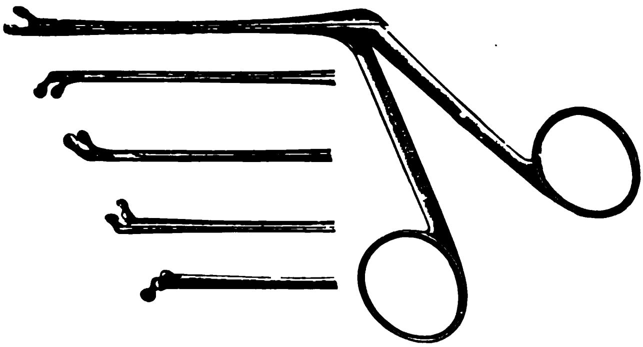
FIG. 119.



Hartmann's punch forceps for removing polypi and granulations.

In many persons of a nervous temperament, as well as in children, it is impossible to use the snare or other instruments unless an anæsthetic is administered. In many individuals it is impossible to lay down rules for any particular plan of treatment. After excising a polypus with the snare, it may be necessary to complete the operation with a ring-knife or sharp spoon, especially if the bony walls of the external meatus or tympanic cavity are carious. The galvano-cautery is recommended highly by some surgeons where the polypus is large and is of the hard or fibrous variety, and when the snare or other instruments cannot be used. It has the advantage over caustic remedies in that its action is more rapid and thorough, while the pain is but momentary, ceasing immediately after the cauterization.

FIG. 120.



Hartmann's forceps.

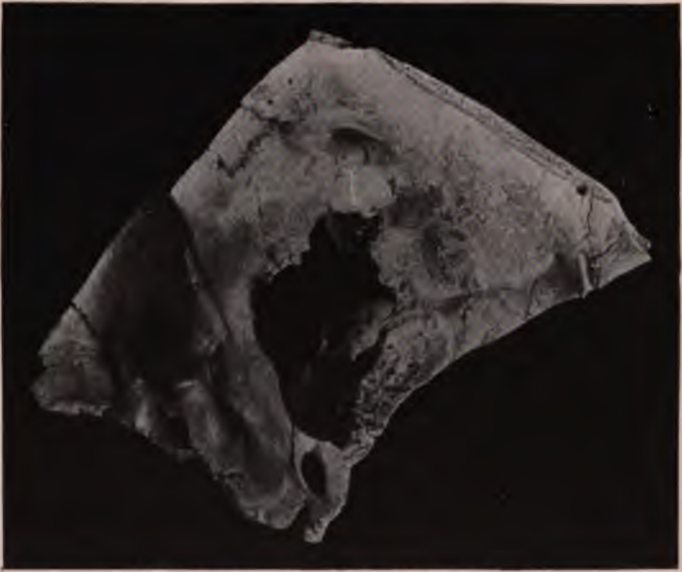
CARIES AND NECROSIS OF THE TEMPORAL BONE.

In acute purulent otitis media, where pain is a prominent symptom, there is probably more or less inflammation of the periosteal lining of the bony meatus and middle ear. This is generally the case when the disease is due to scarlatina, measles, diphtheria, tuberculosis, syphilis, and influenza, and unless vigorous antiphlogistic measures are adopted during the early stage (see Chapter VI.) caries and necrosis of the temporal bone are apt to follow, When acute otitis media passes into the chronic form, and proper drainage has not been established for escape of the pus, polypi and strictures of the external meatus may develop, the secretion is apt to become stagnant, and, as a result, decomposition takes place, so that ulceration of the tissues follows and the bone becomes carious, especially if the patient has scrofula, tuberculosis, or some other cachexia. The extent of the caries may be limited, or there may be extensive destruction of the temporal bone. The microorganisms are not so apt to attack the compact bony tissue as the pneumatic and diploëtic varieties, and the disease is more likely to involve the mastoid cells and the posterior superior wall of the external meatus than the other portions of the temporal bone, although it should not be forgotten that the disease may affect the tympanic roof and give rise to meningitis, or to an extradural or temporosphenoidal abscess, or, starting in the mastoid cells, the destructive process may lay bare the lateral sinus and cause thrombosis of the sinus or an abscess in the cerebellum. Cases have occurred in which the disease has extended to the labyrinth and given rise to symptoms suggestive of an abscess in the cerebellum, viz., nausea, vomiting, vertigo, tinnitus, facial paralysis, great pain, and a staggering gait. In such a case, where the pulse was slow and the patient complained of vertigo, vomiting, severe headache, and deafness, on opening the mastoid antrum a carious condition of the semicircular canals was found, which accounted for all these symptoms. In still another case which came under my care, and in which a diagnosis of "probable cerebellar abscess" was made from the following symptoms, viz., vomiting, a staggering gait with a tendency to fall toward the right side, double choked disk and retinitis, all the alarming symptoms disappeared when the foul-smelling pus and granulations were removed from the external auditory canals and free drainage was established. There was considerable caries of the tympanic cavities as a result of the chronic suppuration.

Still another case of extensive caries of the temporal bone due to chronic otorrhœa occurred in a man, thirty years of age, who was under my care, and who eventually died of a temporosphenoidal abscess. The drumhead was destroyed almost entirely, and there was extensive caries of the inner wall of the middle ear and anterior bony wall of the external meatus (Fig. 121). The case is referred to more fully in the chapter on Intracanial Complications. At the post-mortem examination a large carious opening in the middle cranial fossa was found involving the glenoid fossa.

As a result of caries and necrosis large cavities may be found in the temporal bone. When chronic otorrhœa has existed for some time, and especially when there has been caries of the tympanic walls and ossicula, one finds very frequently a sclerosed condition of the mastoid process, which becomes as hard as ivory. Unhealthy granulations often conceal carious bone, the mucous membrane generally being ulcerated and in an unhealthy condition, while the ossicula are also carious. Caries of the ossicles may occur independently, the disease being limited, as a rule, to one bone, generally the incus.

FIG. 121.



Large carious opening in the middle cranial fossa.

Frequently the body of the incus and head of the malleus are carious. The malleus and incus frequently are found embedded in a mass of granulations. Caries of the handle of the malleus is not often observed, and it is seldom that the malleus alone is involved. The foot-plate of the stapes generally remains *in situ* although the head and crura may be destroyed. If the foot-plate comes away and the labyrinthine fluid escapes through the foramen ovale, profound deafness is apt to follow. A patient may have fairly good hearing, even when the drumhead and the malleus and incus have been destroyed, provided there is no fixation of the foot-plate of the stapes.

Symptoms. Pain is one of the most prominent symptoms, and it is apt to be very severe and continuous, although in tubercular subjects the disease may occur without pain. The pain is sometimes due to retained secretion, but more frequently it is caused by inflammation of the periosteum or of the bone itself. Other symptoms are tinnitus, vomiting, vertigo, nystagmus, insomnia, elevation of temperature with occasional chills, and increased pulse-rate. The discharge is characteristic, being generally increased in quantity, foul-smelling, and containing blood-corpuscles and occasionally gritty particles of necrosed bone. The external meatus generally is filled with granulations which bleed easily. The remaining rim of the drumhead is swollen and red, while, if the antrum is invaded, there may be a bulging of the posterior upper wall of the external meatus. After syringing the canal and drying it with absorbent cotton, the probe is the most valuable instrument for determining the existence of caries. The bony walls of the meatus are sometimes carious, while abscesses form in the soft tissues about the ear, or over the mastoid, or below the auricle. Occasionally, there is an abscess above the pinna, but rarely in front of it. The pus may force its way into the external auditory canal through one of the fissures of Santorini, or it may break through the soft tissues about the auricle, or it may force a passage to the nasopharynx and give rise to a retropharyngeal abscess. As a result of the formation of abscesses, various fistulæ are found, either in the region of the mastoid, or above, in front of, or below the auricle.

Facial paralysis is another symptom of caries of the temporal bone, and may occur as a result of an inflammatory exudation in the sheath of the nerve. There may or may not be caries of the Fallopian canal. When caries occurs, it does not necessarily follow that there will be facial paresis. The paralysis may be permanent, depending largely on the extent of the inflammation. As a result of paralysis, there may be conjunctivitis of the same side with ulceration of the cornea.

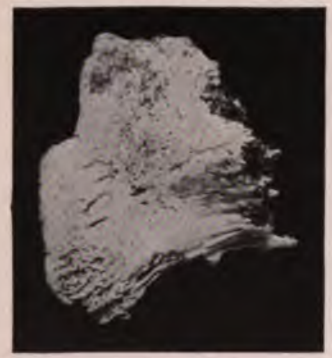
Prognosis. When there is free drainage for the secretion and the patient is otherwise in good health, the prognosis is much more favorable than when caries occurs in individuals suffering from some exhaustive disease. The destructive process may be limited to the attic and tympanic roof, or it may extend to the dura and brain; while, on the other hand, there may be extensive disease of the temporal bone leading to the formation of a large sequestrum without fatal result.

Caries and necrosis may terminate in recovery with or without much loss of bone substance, or various complications may ensue, viz., meningitis, brain abscess, sinus thrombosis, suppurative labyrinthitis, septicæmia, pyæmia, hemorrhage from the internal carotid artery or internal jugular vein.

As a result of deep-seated caries large sequestra may be formed, including a portion or even the whole of the labyrinth. The outer wall of the mastoid process is occasionally exfoliated (see Figs. 122 and 123).

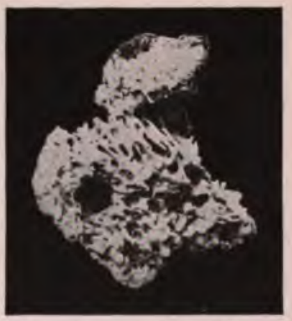
The auditory canal should first of all be syringed with antiseptic solutions, and as perfect drainage as possible established by means of curettes and sharp spoons. In the case of fibrous strictures of the meatus, very small rubber tubing, through which is passed a quill toothpick, may be used, the quill keeping the tube pervious for escape of the pus, while the rubber exerts elastic pressure on the walls of the meatus. Sometimes caseous masses in the middle ear are forced out and the pain is relieved by syringing with a warm boric acid solution through the Eustachian tube.

FIG. 122.



Sequestrum consisting of the outer wall of the mastoid process.

FIG. 123.



Sequestrum consisting of a portion of the mastoid process.

Whenever possible, the carious bone should be scraped and any loose sequestra removed. Scraping of the bone is indicated only when the disease is superficial, and even then care should be exercised not to penetrate the labyrinth if the inner tympanic wall is in a carious condition. The surgeon should likewise be careful not to injure the Fallopian canal and cause facial paralysis, nor to penetrate the middle cranial fossa through the tympanic roof. In this connection it is well to bear in mind that the nerve as it passes over the fernestra ovalis is frequently covered inferiorly by mucous membrane and periosteum only. After such an operation on the bone, the auditory canal and middle ear should be syringed with bichloride solution, and powdered iodoform or iodoform and boric acid insufflated. Boric acid gauze and absorbent cotton should then be inserted in the meatus.

When a sequestrum has formed, it should be grasped with suitable forceps, and extracted through the external auditory canal, if possible ; very little force should be employed. In the majority of cases, especially when the disease is extensive, it is much better to cut down on the mastoid, making the incision close to the auricle and down to the bone. The auricle should then be displaced forward, and the cartilaginous canal separated from its attachment, in order to allow more space for the operator. If the disease is extensive, it may be necessary to enter the antrum and cut away the posterior superior bony wall, and make one large cavity of this portion of the temporal bone (see Schwartze-Stacke operation).

General Treatment. While local treatment is of especial importance, attention to the patient's general health should never be neglected. As the disease is apt to occur in those who are debilitated, it is highly important to prescribe a nourishing diet, if possible, and plenty of out-of-door life. Cod-liver oil, the hypophosphites, and syrup of the iodide of iron are particularly valuable in tuberculous or strumous children. Iron, quinine, and strychnine are indicated in anæmia, while iodide of potash should be given if the cause can be traced to syphilis.

Treatment of Facial Paralysis. Large doses of iodide of potash are recommended by some in the early stage when the bone is first inflamed. Counter-irritation over the mastoid by means of iodine ointment is advised by others. The discharge from the ear should be properly treated, and any carious bone removed. After the inflammatory symptoms have subsided, electricity should be tried. If the muscles do not respond to the faradic current, galvanism should be substituted. Frequently no improvement follows until weeks have elapsed, and in some cases even many months.

When the patient has had the paralysis for a year or more, and there seems to be no evidences of improvement, the surgeon should consider the advisability of uniting the facial with one of the neighboring motor nerves. Of twenty-five cases already reported, the results obtained have been very satisfactory in the great majority of cases according to F. Furet. In seven of these cases the facial was joined with the hypoglossal nerve, while in the others the facial and spinal accessory were united. Ballance and others recommend the hypoglossal-facial operation. In cases of anastomosis between the spinal accessory and facial, the movements of the arm and elevation of the shoulder of the side operated on, at once cause a contraction on the corresponding side of the face. The results seem to show disappearance of degenerative action, diminution of facial asymmetry and among most of the cases partial reestablishment of the mobility. According to Furet one notices at the sixth month after operation an improvement in the reestablishment of symmetry of the face in repose, while later, in favorable cases, there is a return of certain voluntary movements such as closure of the eye-lid and deviation of the labial commissure, with improvement in phonation and mastication. The cure can be further hastened by gentle massage and electricity.

CHAPTER XI.

DISEASES OF THE MASTOID PROCESS.

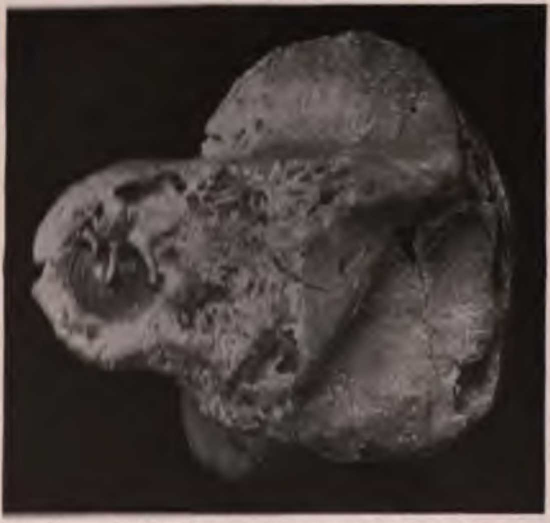
BEFORE entering into a consideration of the diseases of the mastoid process and their complications, it is necessary to consider the anatomy of the temporal bone, as well as its position in relation to important structures, such as the large bloodvessels, the dura mater, and the brain.

The temporal bone consists of a squamous, a petrous, and a mastoid portion. Ossification of the temporal is developed by ten centres, viz., six for the petrous and mastoid portions, one for the squamous and zygoma, one for the tympanic plate, and two for the styloid process. Inflammatory changes of a destructive character are more apt to take place in the petrous and mastoid portions than in the squamous and tympanic. During the first years of life the points of union between these different portions are very vascular, and at times are not firmly united, so that inflammatory products, especially tubercle bacilli, can easily break through these vascular walls and give rise to a collection of pus in the soft tissues behind the auricle, a condition of affairs which is of frequent occurrence in scrofulous children.

In the child the external auditory canal is as large in proportion as in the adult, except that in the former the canal consists almost wholly of cartilage, while in the adult it is bony for two-thirds of its length.

In the infant at birth there is an incomplete ring with two tubercles, one in front and one behind; these tubercles approximate one another in the lower wall of the meatus at the glenoid fossa, and form a foramen which does not become closed until the fifth or sixth year of age. This aperture, however, sometimes remains open permanently, or it may be covered by thin fibrous tissue, and, as it is in close proximity to the parotid gland, it is easy to understand how inflammation may extend from the external meatus to the parotid gland, or *vice versâ*. During an attack of mumps the drumhead frequently is congested, and in some cases the labyrinth is affected as well.

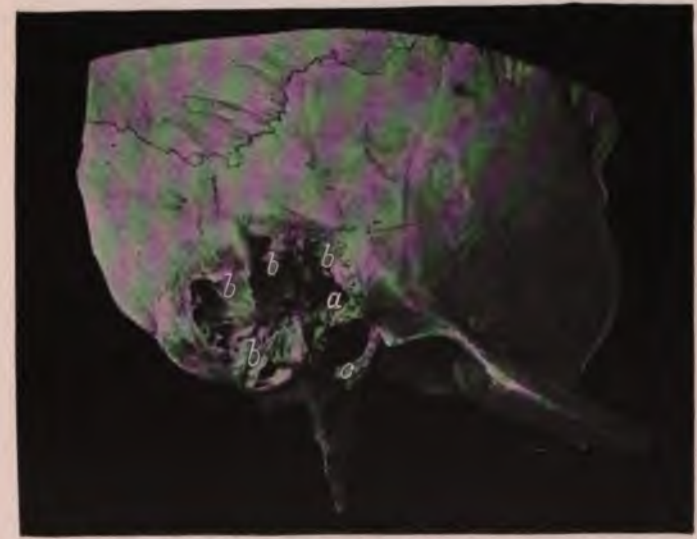
FIG. 124.



Section of bone showing the inner or mucous surface of the drumhead, also the articulation of the head of the malleus with the body of the incus contained within the attic.

The tympanum communicates with the Eustachian tube in front and the mastoid antrum and cells behind. The drumhead forms the greater part of its outer wall. Beneath the floor of the tympanum, and separated from it by bone, is the jugular fossa posteriorly and the carotid artery anteriorly. In the upper portion of the tympanum is the attic (Fig. 124), containing the articulation of the head of the malleus with the incus; the attic opens posteriorly into the mastoid antrum (Fig. 125) and the latter into the mastoid cells. Some writers describe a third cavity, viz., the aditus ad antrum, which is the passage between the attic and the antrum. The tegmen tympani, or roof of the middle ear, consists of a very thin plate of bone, upon which rest the dura

FIG. 125.



a. Antrum. *b*, *b*, *b*, *b*. Mastoid cells. *c*. External osseous meatus.

mater and brain. In some cases there are defects in the tegmen tympani, which are covered over with fibrous tissue, so that in acute otitis media the inflammation may extend directly to the dura and give rise to meningitis or brain abscess. In cases of fracture of the temporal bone the tympanic roof may be involved, symptoms indicative of this complication being escape from the meatus of blood and cerebrospinal fluid.

Macewen[1] enumerates the following communications with the tympanic cavity, and states that pathological processes may extend through these apertures, viz.:

1. The external auditory meatus.
2. The Eustachian tube and canal for the tensor tympani muscle.
3. The mastoid antrum and cells.
4. The petro-squamosal fissure running the whole length of the tegmen tympani, open in early years, and marked by numerous channels in after-life.
5. The masto-squamosal fissure, open in childhood, occasionally remaining unossified in after life, and marked by numerous foramina when ossified.
6. The fenestræ ovalis and rotunda communicate with the vestibule and cochlea, respectively, and the former communicates with the internal meatus; a venous canal from the cochlea communicates with the pyramidal part of the jugular fossa.
7. The Fallopian canal, having communications with the tympanic cavity: in infancy, by a defect in its anterior wall above the fenestra ovalis, and permanently by the aperture for the stapedius muscle and the small nerve twig for the same; by the channel for the chorda tympani, which again pierces the wall of the tympanum

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[1] Pyogenic Infective Diseases of the Brain and Spinal Cord, pages 5-7.

at the canal of Huguier in the fissure of Glaser; by an arterial twig, the stylo-mastoid branch of the posterior auricular, which passes into the tympanum.

The Fallopian aqueduct opens above the cribriform plate into the internal meatus, and through the hiatus Fallopii and a smaller hiatus in front of this (transmitting the greater and lesser superficial petrosal nerves, respectively) into the middle cranial fossa, so inflammation may extend along the perineural sheaths and set up lepto-meningitis of both posterior and middle fossæ.

8. The foramen between the carotid canal and the jugular fossa for Jacobson's nerve to the sympathetic plexus and inner wall of the tympanum.

9. The fossa subarcuata—in childhood a wide foramen transmitting a vein to the cells under the superior semicircular canal, and at a still earlier period to the mastoid cells near the outer aspect of the infantile mastoid.

10. The lateral and sigmoid sinus—by means of numerous minute veins through the posterior and lower part of the tegmen tympani and through the mastoid antrum and cells.

11. The superior petrosal sinus—by means of numerous minute venous channels.

12. The inferior petrosal sinus—by means of veins from the labyrinth.

13. The temporo-maxillary vein—by many minute veins from the anterior part of the tympanic cavity.

14. Free communication through the bone with the dura matral system of veins.

15. The carotid canal—pierced by several foramina for nutrient vessels and branches of the sympathetic nerves to the tympanum, also by small veins.

hearing, even when the drumhead and the malleus and incus have been destroyed, provided there is no fixation of the foot-plate of the stapes.

Symptoms. Pain is one of the most prominent symptoms, and it is apt to be very severe and continuous, although in tubercular subjects the disease may occur without pain. The pain is sometimes due to retained secretion, but more frequently it is caused by inflammation of the periosteum or of the bone itself. Other symptoms are tinnitus, vomiting, vertigo, nystagmus, insomnia, elevation of temperature with occasional chills, and increased pulse-rate. The discharge is characteristic, being generally increased in quantity, foul-smelling, and containing blood-corpuscles and occasionally gritty particles of necrosed bone. The external meatus generally is filled with granulations which bleed easily. The remaining rim of the drumhead is swollen and red, while, if the antrum is invaded, there may be a bulging of the posterior upper wall of the external meatus. After syringing the canal and drying it with absorbent cotton, the probe is the most valuable instrument for determining the existence of caries. The bony walls of the meatus are sometimes carious, while abscesses form in the soft tissues about the ear, or over the mastoid, or below the auricle. Occasionally, there is an abscess above the pinna, but rarely in front of it. The pus may force its way into the external auditory canal through one of the fissures of Santorini, or it may break through the soft tissues about the auricle, or it may force a passage to the nasopharynx and give rise to a retropharyngeal abscess. As a result of the formation of abscesses, various fistulæ are found, either in the region of the mastoid, or above, in front of, or below the auricle.

Facial paralysis is another symptom of caries of the temporal bone, and may occur as a result of an inflammatory exudation in the sheath of the nerve. There may or may not be caries of the Fallopian canal. When caries occurs, it does not necessarily follow that there will be facial paresis. The paralysis may be permanent, depending largely on the extent of the inflammation. As a result of paralysis, there may be conjunctivitis of the same side with ulceration of the cornea.

Prognosis. When there is free drainage for the secretion and the patient is otherwise in good health, the prognosis is much more favorable than when caries occurs in individuals suffering from some exhaustive disease. The destructive process may be limited to the attic and tympanic roof, or it may extend to the dura and brain; while, on the other hand, there may be extensive disease of the temporal bone leading to the formation of a large sequestrum without fatal result.

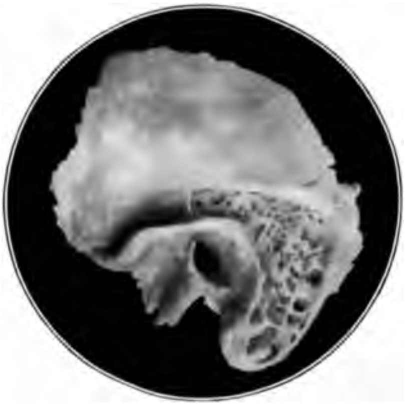
Caries and necrosis may terminate in recovery with or without much loss of bone substance, or various complications may ensue, viz., meningitis, brain abscess, sinus thrombosis, suppurative labyrinthitis, septicæmia, pyæmia, hemorrhage from the internal carotid artery or internal jugular vein.

As a result of deep-seated caries large sequestra may be formed, including a portion or even the whole of the labyrinth. The outer wall of the mastoid process is occasionally exfoliated (see Figs. 122 and 123).

The auditory canal should first of all be syringed with antiseptic solutions, and as perfect drainage as possible established by means of curettes and sharp spoons. In the case of fibrous strictures of the meatus, very small rubber tubing, through which is passed a quill toothpick, may be used, the quill keeping the tube

When the chorda tympani nerve is injured, as may happen from a blow or fall, or from instrumental manipulation, there will occasionally be observed a loss of the sense of taste in the anterior two-thirds of the tongue on the side affected. The facial nerve may be paralyzed in its course through the middle ear from injury due to an operation, or from disease of the middle ear, or the facial paralysis may be of central origin. As a result of such paralysis conjunctivitis occurs, and occasionally ulcerations on the cornea, the patient being unable to close the eye. The sense of smell is impaired. The patient has difficulty in mastication, the food collecting between the cheek and gums on the affected side. Taste is affected through the chorda tympani. The patient is unable to whistle. In paralysis of the facial due to a central lesion, the patient generally can close the affected eye, and the muscles of the face are much less affected, while the chorda tympani is not involved. The facial paralysis, when due to middle or internal ear disease, is on the same side as the lesion; but when of cortical origin, or due to a lesion of the internal capsule, the paralysis is on the opposite side. In children, the wall of the canal for the facial is extremely thin, and occasionally there is a small opening in this wall, so that facial paralysis is of more frequent occurrence in children than in adults. It is important to remember the course of the Fallopian canal, for the surgeon is likely to injure the nerve during operations on the mastoid as well as when excising carious ossicles. The facial canal, in its course through the upper parts of the tympanum, lies just above the foramen ovale and directly behind the attic and antrum, so that the surgeon should avoid the inner and anterior wall of the antrum. After removing carious ossicles, great care should be exercised in scraping the attic. The patient's face should constantly be watched, to see that there is no twitching of the facial muscles Even when this precaution has been taken, facial paralysis has occurred, as the muscles will probably not respond to stimulation when the patient is completely under the influence of an anæsthetic. In early life the mastoid process is but slightly developed, and consists principally of the antrum, which is large and very near the surface of the skull. The ossicula in the infant are of almost the same size as in the adult.

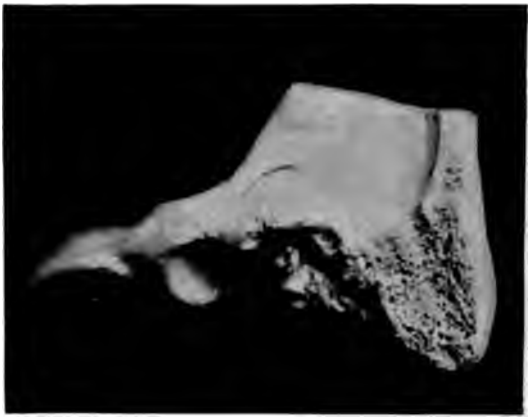
Fig. 128.



Pneumatic mastoid process.

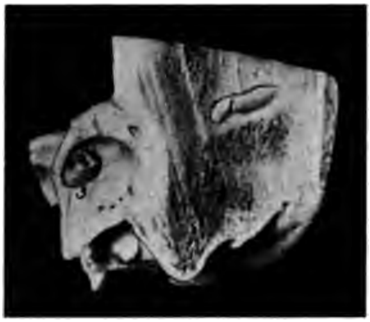
The mastoid cells in adult life vary very much as to size, and from anatomical investigations it is known that no two processes are exactly alike. The cells in one case may consist of large air-spaces, which communicate with one another, as in Fig. 18, the so-called pneumatic mastoid process, or they may be arranged as in Fig. 128; or the mastoid process (Figs. 129 and 130) may be composed of small-celled diploë and osseous tissue filled with fatty substances; or the mastoid process may be sclerosed. The pneumatic mastoid process is generally

FIG. 129.



Inner surface of a diploëtic mastoid process, with the groove for the sigmoid sinus lying just above the cells.

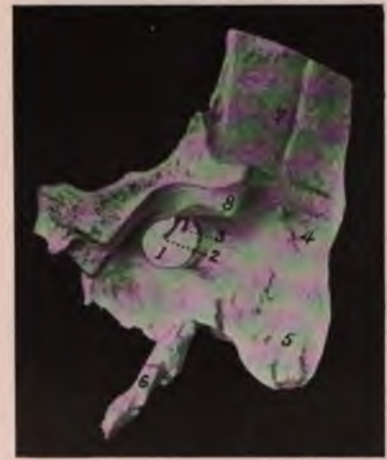
FIG. 130.



Section through diploëtic mastoid.
1. Lateral sinus. 2. Mastoid cells. 3. Anterior canal wall cut away to show membrana tympani.

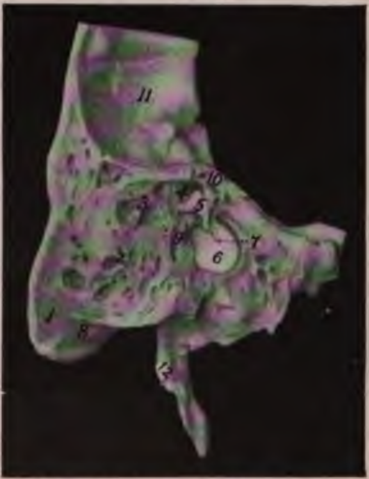
larger than either the diploëtic or sclerosed varieties. In some cases the mastoid is composed partly of pneumatic cells and partly of diploëtic tissue. According to my experience, in cases in which the external wall of the mastoid process is small, and especially when the lower portion is poorly developed, the lateral sinus is more likely to run closer to the antrum than in those cases in which the mastoid is filled with large air-cells. In such, moreover, great care should be taken not to injure the sinus when opening the mastoid antrum. The bony wall between the mastoid cells and the sigmoid sinus is very thin, and in some cases there are defects in the bone which are filled in with fibrous tissue. An unusual error in the development of the jugular fossa will be observed in Fig. 135.

FIG. 131.



Anterior bony canal wall cut away to show membrana tympani. 1, membrana tympani; 2, umbo; 3, long process of incus; 4, suprameatal spine; 5, mastoid process; 6, styloid process; 7, squamous portion; 8, middle root of zygoma.

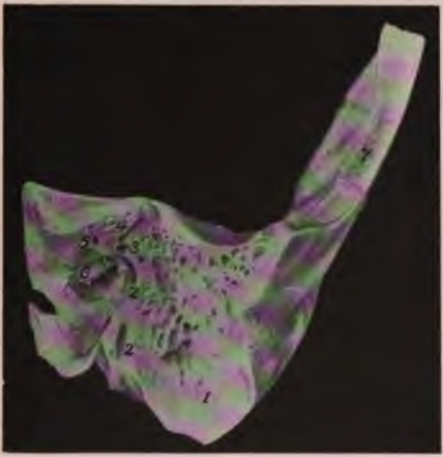
FIG. 132.



Mixed variety showing diploëtic and pneumatic mastoid cells. 1, diploëtic tissue in tip; 2, pneumatic cells; 3, antrum; 4, attic; 5, incus; 6, membrana tympani; 7, umbo; 8, digastric groove; 9, aquæductus Fallopii; 10, tegmen tympani; 11, squama.

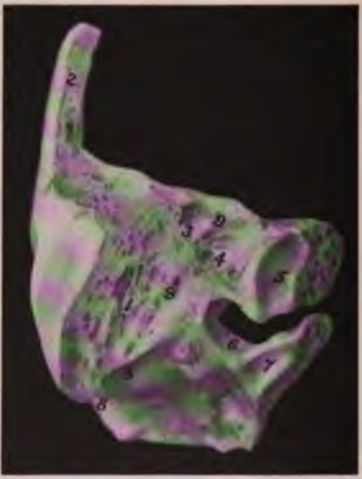
In the child there is an opening found in the petrous bone on its posterior surface, the fossa subarcuata, lying between the external auditory meatus and the groove for the superior petrosal sinus. It terminates in a series of cells just beneath the superior semicircular canal. Soon after birth this canal gradually fills up with more or less bony tissue, so that eventually it is but a small sinus. It is usually of small size in the adult, and as a rule it is closed. It is of importance because, when present, inflammation may extend from the

FIG. 133.



Mixed variety showing diploëtic and sclerosed mastoid. 1, sclerosed tip—diploëtic tissue above; 2, aquæductus Fallopii; 3, horizontal semicircular canal; 4, superior semicircular canal; 5, junction of hiatus with the aquæductus Fallopii; 6, promontory.

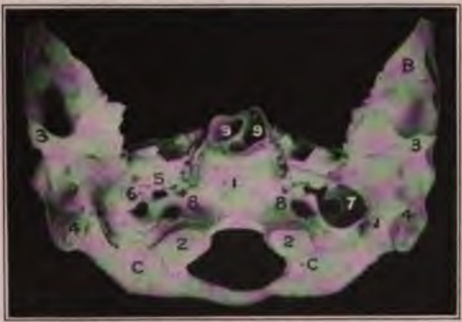
FIG. 134.



Mixed variety showing pneumatic and diploëtic mastoid cells in an unusually thick bone. 1, pneumatic cells—diploëtic above; 2, portion of parietal bone showing continuation of cells; 3, antrum; 4, promontory; 5, portion of carotid canal; 6, jugular fossa; 7, groove between condyle of occipital bone and the foramen lacerum posterium; 8, digastric and occipital grooves; 9, aquæductus Fallopii.

mastoid cells to the brain, as a vein enveloped in dura mater passes through it. The mastoid antrum, in the child just after birth, is covered by a much thinner layer of bone than in the adult, so that pus makes its way much more readily to the external surface of the skull. The mastoid process does not assume the typical shape until the child is about three years of age. The mastoid antrum is the point which the surgeon should always expose when operating for mastoid disease, especially when some intracranial complication has occurred, for it is there that most pathogenic processes have their origin.

FIG. 135.



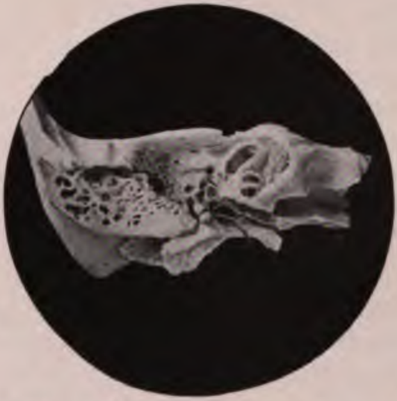
Temporal and occipital bones viewed from below, showing error in development of right jugular fossa. A. Squama of right temporal. B. Squama of left temporal. C.C. Occipital bone. 1. Basilar process. 2. 2. Condyles. 3. 3. Zygomatic processes. 4. 4. Mastoid processes. 5. Separate opening for exit of inferior petrosal sinus. 6. Error in development resulting in absence of right jugular fossa, which is represented by an opening for exit of the sinus. 7. Left jugular fossa, somewhat overdeveloped. 8. 8. Anterior condyloid foramina. 9. Portion of sphenoid cells.

MASTOIDITIS EXTERNA.

PRIMARY ACUTE INFLAMMATION OF THE MASTOID PERIOSTEUM.

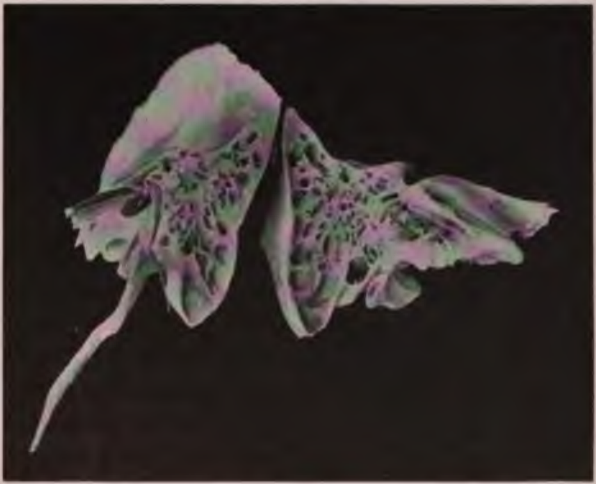
Primary acute inflammation of the periosteum covering the mastoid process, is rare, although such cases do occur and have been reported, the congestion first appearing in the periosteum covering the mastoid. The causation of *mastoid periostitis* is frequently obscure, but it may be due to cold, injury, or extension of the inflammation from a furuncular condition of the external meatus. The hearing in such cases is generally normal, as no changes are apt to take place in the drumhead. There may be a slight congestion of the posterior bony wall of the external meatus. The auricle generally stands out prominently, while the tissues over the mastoid are painful to the touch, red, and œdematous. The pain is apt to be severe in some cases, and there may or may not be considerable fever. When one or more furuncles have formed in the external meatus, the inflammation may extend to the soft tissues about the ear, and especially in the mastoid region, so that the parts are very tender and œdematous, with the auricle standing out prominently. The beginner is very likely to mistake this condition for disease of the mastoid process, but the presence of a furuncle in the canal will give the surgeon a clue to the causation. It is possible, however, in severe cases of acute otitis media, for the periosteum over the mastoid process to be affected, especially in strumous subjects. Unless a free incision is made down to the bone, there is a liability that the latter will become involved and the inflammatory process extend to the mastoid cells. The disease may run

FIG. 136.



Upper portion of temporal bone removed, showing tympanum, with ossicles in position, mastoid, antrum and cells, semicircular canals, cochlea and internal auditory canal.

FIG. 137.



Section through temporal bone, showing pneumatic mastoid cells and an unusually long stylomastoid process.

its course in a few days and subside rapidly, or suppuration may take place. The abscess may open into the external meatus through one of the incisuræ Santorini. As a result of periostitis, the superficial layers of bone underneath may become necrosed unless an incision is made through the periosteum down to the bone. In the early stage of this affection the artificial leech should be applied, followed by the Leiter cold coil. If these measures do not afford relief, a free incision should be made through the soft tissues over the mastoid down to the bone. If the bone beneath has become carious, this should be removed with chisels and gouges.

MASTOIDITIS INTERNA.

PRIMARY ACUTE INFLAMMATION OF THE MASTOID CELLS.

Cases have been reported from time to time, and undoubtedly occur, in which the mastoid cells are primarily involved. The disease may be due to cold, trauma, syphilis, tuberculosis, or the influenza, or may develop spontaneously. The micro-organisms of influenza, or the diplococcus pneumoniæ may be found in this disease, as well as other microbes.

Henrici, of Rostock, has reported eight cases of tuberculosis in the mastoid in children and has added the histories of three more cases under seven and two in the eighth year. His combined statistics show that primary tuberculosis of the mastoid process occurs in somewhat less than one sixth of the cases of mastoiditis of children. According to this author, this form has especial interest on account of its character as primary bone tuberculosis, and not as a disease transmitted from bone tuberculosis of the tympanum. The usual mastoid operation generally leads to recovery, although the period of recovery is somewhat prolonged. The prognosis is more unfavorable the younger the child. This writer believes that the primary form is much more frequent than tuberculous mastoiditis extending from the tympanum.

The symptoms are pain in the region of the mastoid, which, though slight at first, usually becomes very severe and throbbing. This is followed by tenderness on pressure over the mastoid bone, and if the pus makes its way through the bony wall fluctuation will be detected in the soft parts and the auricle will stand out prominently. In this affection the disease may reach its height in a week or ten days, and the inflammation subside without suppuration, or an abscess may form, which may perforate the outer cortex after several weeks of suffering. There is always danger that the inflammation may extend to the sigmoid sinus if pus forms and is not evacuated, or that the dura may become involved through the thin tympanic roof.

As in periostitis of the mastoid, so in this disease, the hearing usually is unaffected. It is difficult to make a differential diagnosis between primary mastoiditis and mastoid periostitis, except that in the former the pain is deeper seated. If a subperiosteal abscess has already developed, it will be impossible to tell whether the mastoid cells are implicated until a free incision has been made down to the bone and the latter has been examined for a sinus. It is always well in such cases to open the cells to see if pus has formed.

Prognosis. The prognosis is usually favorable in simple, uncomplicated cases. The surgeon should be guarded in expressing an opinion, however, when the disease occurs in a syphilitic or cachectic individual.

Treatment. The treatment of this disease is similar to that for acute mastoid inflammation occurring secondarily to acute purulent otitis media.

Acute Inflammation of the Mastoid Cells occurring in connection with Acute Suppurative Otitis Media.

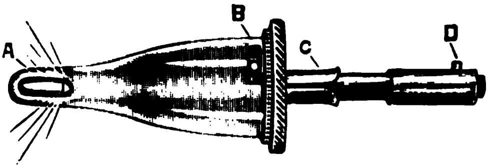
Inflammation of the mastoid cells occurring secondarily to acute otitis media is the form most frequently observed. The disease starts generally in the nasopharynx, and extends by the Eustachian tube to the tympanum, and thence through the antrum to the mastoid cells. The inflammation of the cells may follow an acute catarrhal or acute suppurative otitis media, or occur as the result of chronic purulent otitis media, frequently of long standing. Mastoid disease developing in connection with chronic purulent inflammation of the middle ear will be described separately.

Acute inflammation of the mastoid cells may follow prolonged exposure to wet or cold. Other causes are the exanthematous diseases, diphtheria, tonsillitis, bronchitis, typhus and typhoid fevers, tuberculosis, syphilis, influenza, the use of the nasal douche, and "sniffing up" salt and water for the relief of nasal catarrh. It is probable that in almost all cases of acute otitis media the mucous lining of the mastoid cells is simultaneously involved. The diploëtic mastoid cells are not affected as often as the pneumatic variety. In some pneumatic processes the opening from the antrum into the cells is large. If, however, the opening is small, or it becomes occluded through swelling of the mucous membrane the escape of pus is prevented, and the discharge, being forced back, forms an abscess.

Since the influenza made its appearance in this country there have been, according to my experience, many more cases of mastoid disease than ever before. It is only a few years ago that but twelve, or at most twenty, cases of this disease were recorded in the annual report of the New York Eye and Ear Infirmary. In the report for 1896 there were 135 mastoid operations, while for 1897 the number had increased to 161, and in 1916 to 614. Formerly, it was the exception for both mastoid processes to be involved simultaneously in a case of acute otitis media. During the past few years such a condition of affairs has been very frequent. A patient will have a sudden severe earache, which is followed in a few hours by a bulging of the drumhead and symptoms of mastoid inflammation. Of twenty cases that came under my observation recently in private practice, all had acute otitis media. In seventeen there was acute inflammation of the mastoid cells, and in seven it was necessary to open the mastoid process. In ten recovery took place without operation. Of these, the drumhead was incised in six cases. In one of them, viz., that of an infant, several months old, in whom alarming symptoms developed suddenly, suggesting a meningeal complication, puncture of the drumhead gave speedy and marked relief.

Symptoms. The most prominent symptom is pain in the mastoid process, which radiates usually in different directions—upward in the temporal region and downward and forward toward the teeth. Great pain is felt on percussion of the bone or when firm pressure is made. The pain on pressure usually is limited to the region just over the mastoid antrum or to the middle and lower thirds, especially at the tip. Sensitiveness to pressure does not necessarily signify that the bone is diseased at that particular point only, so that it is always important to make a careful examination of the entire mastoid process during an operation in this region. In some cases pus forms in the mastoid cavity with very little, if any, pain. This frequently happens when the disease occurs in connection with tuberculosis, influenza and the exanthematous diseases. As mastoid disease is observed frequently during the course of scarlatina, diphtheria, and other infectious diseases, it is most imperative for the surgeon to make a *free incision in the drumhead* at an early date. An abscess in the mastoid cells, occurring secondarily to acute purulent otitis media, is more likely to be located in the middle and lower thirds than in the upper third. Other symptoms of mastoid inflammation are: increase of surface temperature of the affected side; bulging of the posterior and upper portions of the drumhead, with drooping of the adjacent soft parts of the external meatus; after perforation has occurred, the appearance of a nipple-like process, at the extremity of which is found a minute opening, and profuse discharge from the ear. The temperature may vary from 99.5° to 104° or 105° F. As a rule, in simple, uncomplicated cases it is lower in adults than in children. A patient with extensive caries of the mastoid cells and with a carious opening into the cranial cavity may have a temperature but slightly above normal, so that a comparatively low temperature does not necessarily signify that the case is not one of considerable gravity. Not long ago a patient was admitted to my service at the Infirmary with an acute purulent otitis media. There was absolutely no pain on pressure over any portion of the mastoid process. As the discharge continued to be very profuse in spite of all treatment and the patient had a very septic appearance with a badly coated tongue, a mastoid operation was performed. The mastoid cells were filled with pus and the bone was very much diseased. That the patient did not complain ot pain when pressure was made on the bone was due to the fact, probably, that the outer cortex was very thick. The profuse discharge in this instance was the principal symptom. Young infants frequently have a temperature of 105°, while in adults one is much more apt to find the temperature below 100° F., even when extensive mastoid disease occurs. Great surprise is often expressed by the general practitioner that there can be any serious disease with such a low temperature. I have never seen a case of acute inflammation of the mastoid cells without slight elevation of temperature, except in a few instances and I look upon this symptom as having a very important bearing on the diagnosis. If a patient is under observation who has had an acute purulent otitis media for a week or ten days, and an examination reveals bulging of the upper wall of the auditory canal and drumhead, and there is pain on pressure over the mastoid antrum or tip; and, further, if there is some rise in temperature, frequently very slight, and especially if there is a profuse discharge, these symptoms taken together are very characteristic of mastoid inflammation. The condition of both mastoid processes should always be compared, because in some persons pressure made over the normal mastoid causes pain, especially in nervous subjects. Bulging of the upper and posterior portion of the drumhead and drooping of the adjacent cutaneous lining of the external meatus are, to my mind, absolute symptoms of mastoid involvement, and I believe that in such cases it is always necessary to perforate the mastoid cells. Formerly it was taught that œdema and redness of the tissues behind the ear, with prominence of the auricle, were evidences of mastoid disease. Surgeons have frequently waited for these symptoms, as well as for the appearance of fluctuation. An operation should never be deferred till such a late stage, as valuable time may be lost by so doing. The fact should not be overlooked that redness and œdema over the mastoid, and tenderness on pressure, occur in cases of furunculosis of the external meatus. An examination of the auditory canal will exclude this. Transillumination of the mastoid is of value in some cases, especially when one is in doubt. Mosher,[1] of Boston, has devised a very useful instrument for this purpose (Fig. 138), which consists of an ear speculum, closed at both ends, but with a window on one side near the tip, through which the rays of an electric light are transmitted. There is an air space

FIG. 138.



Dr. Mosher's instrument for transillumination of the mastoid cells.

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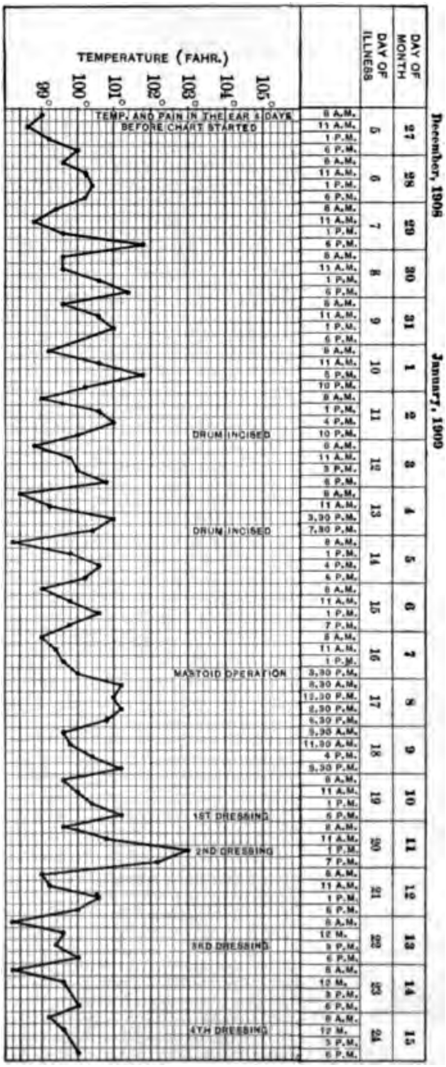
[1] Laryngoscope, January, 1912.

about the lamp, so that the speculum heats up very slowly. The current can be obtained from four dry cells controlled by a rheostat, or by means of the Wappler controller the street current can be utilized. The patient is taken into a darkened room, the lamp adjusted to its maximum brilliancy, and the speculum inserted into the auditory canal with the window placed posteriorly. It is made to close the meatus firmly so that no light comes through the auricle.

A case was lately brought to my attention by the family physician on account of certain symptoms suggestive of mastoid disease. The patient, a young lady of seventeen, had an attack of chickenpox, and at the same time complained of severe pain in the ear and over the mastoid process. She had a temperature of 101½° F. The external auditory canal was swollen, so that is was impossible to obtain a good view of the drumhead. The tissues over the mastoid were very tender to the touch and œdematous. The hearing-distance, however, was normal, and a careful inspection of the inflamed tissues showed the cause to be due to the presence of papules beneath the skin.

Formerly the view was entertained by physicians generally that a patient could not have any serious trouble with the ear if there was not considerable pain, and at the present time it is often difficult for the otologist to convince the family physician that some of the most serious cases are those in which the pain is slight or at times absent. This statement applies particularly to cases occurring in early life, in which the infection is often a virulent one and the temperature is apt to be high. That a very slight earache and one of very short duration may lead to a mastoid operation is shown in the report of the following case: The patient, a girl of seven, was seen by me in consultation on December 29, 1908. The history was that a week before she had had a very slight earache on the left side, which subsided inside of an hour, and she did not complain of that ear again until to-day, when the drumhead ruptured spontaneously. During the preceding week she had some elevation of temperature, but it did not rise above 101⅘° F. (see Fig. 139). As she had intestinal catarrh during this time the attending physician considered that the temperature was due to this and not to any aural complication. The discharge from the ear was mucopurulent and very copious. There was no tenderness over the mastoid on pressure. On January 2, 1909, the drumhead was incised, as the perforation was small, when thick creamy pus under pressure escaped. The patient's condition had improved up to this time, but the discharge had become scanty. On January 3 there was a slight sensitiveness, when pressure was made over the lower third of the mastoid, and as there was some bulging of the drumhead and swelling of the upper canal wall, the membrana tympani was again incised on January 4. A culture was made from the pus taken from the middle ear, and it proved to be a pure staphylococcus infection. The mastoid process was opened on January 7, as the tenderness over the mastoid was more marked, the discharge more profuse, and the posterior and upper canal wall was drooping. The child also was irritable. The blood count showed that the polymorphonuclear elements had increased from 68.2 per cent. on January 4 to 71 per cent.

FIG. 139.

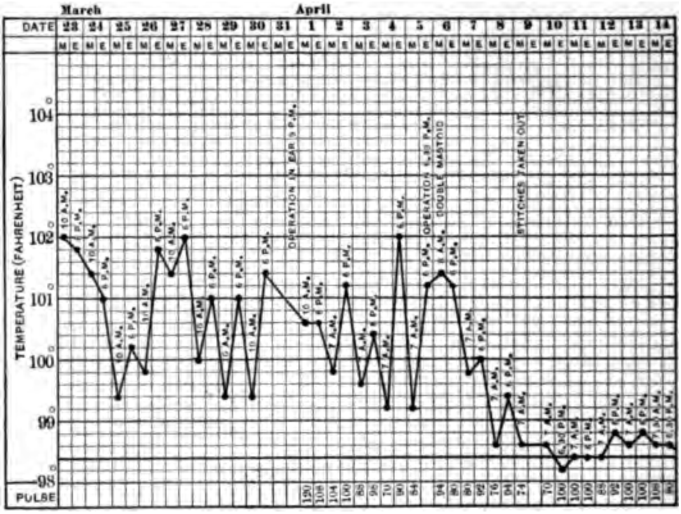


A case of mastoid disease characterized by absence pain of and by very slight tenderness to pressure on the mastoid process.

on January 6, while the leucocytes had decreased slightly. The mastoid bone was of the pneumatic variety and was filled with some pus as well as granulations and softened bone. The child made a good recovery.

A boy, six and one-half years old, came under my care a short time ago, and the case seemed to be a very mild

FIG. 140.



Acute suppurative otitis media and acute mastoiditis of both sides.

one at first, but later it became necessary to open both mastoid processes. He had been in rather poor health during the winter, and had been sent to Atlantic City to recover. He took cold and had a slight earache on the right side, but it did not seem to amount to anything, except that he had had continuous fever for ten days when I first saw him (Fig. 140). He had been given antipyretics, and it was thought by the attending physician that he might have typhoid fever. Three days before he was brought to me he had pain in the left ear, and the deafness became quite marked on both sides. Both drumheads were bulging and were incised under nitrous oxide gas: serum and blood escaped. The boy seemed to do well for several days, but the tenderness over both mastoid processes, which was present when I first saw him, became more marked, and on the fifth day after his arrival in town I had to open both mastoid processes, which I found full of pus, granulations, and softened bone. The leucocytosis just before the operations was 16,000. Smears taken from the discharge from the auditory canals showed the presence of the staphylococcus on the right side, and the staphylococcus and the streptococcus on the left. The wounds healed and the patient recovered. This case is mentioned to show the importance of carefully examining the ears in children even if the pain is slight, particularly if there is a temperature which persists. Continuous fever in a child who has had a slight earache is a most important symptom, and is usually due to sero-pus in the tympanic cavity.

In children where a discharge keeps up for three or four weeks, and especially when the membrana tympani seems swollen and of a dull red color, the case usually cannot be cured without opening the mastoid antrum from behind, and in such cases it is the rule to find granulations.

In another class of cases a child may have an acute purulent otitis media which apparently is cured, although the drumhead does not resume its normal appearance, and later the discharge from the ear reappears. This is probably due to the fact that a focus of infection has remained in the tympanum, and in such cases a mastoid operation is frequently required.

Acute inflammation of the mastoid cells may terminate in recovery without the formation of an abscess, but more frequently suppuration occurs and carious destruction of the bone results, so that after weeks of suffering a large sequestrum may be found. In influenza cases rapid destruction of bone is the rule, so that it is imperative in such to open the cells very early. The pus may force its way through the tympanic roof, and give rise to meningitis or brain-abscess, or may cause destruction of the thin plate of bone covering the sigmoid sinus and produce thrombosis, or perforation may take place at the mastoid tip (Bezold), thus allowing the septic matter to burrow beneath the deep fascia, and give rise to septicæmia and pyæmia, or to a postpharyngeal abscess.

In the pneumatic mastoid process, where the cells are large and the outer cortex thin, the pus is more likely to force a passage externally and form a subperiosteal abscess than in the diploëtic and sclerosed processes. In the latter, according to my experience, the tendency is for the pus to escape through a carious opening in the tympanic roof, and to give rise to an extradural abscess or an abscess in the brain-substance itself.

Facial paralysis is observed in some instances as a result of disease of the mastoid process itself as well as of injury inflicted by the surgeon during an operation. In a child, one and one-half years of age, in whom facial paralysis made its appearance before operation, the mastoid cells were found extensively diseased, so that it was necessary to remove bone in all directions. Although the prognosis as to recovery from the paralysis in such cases usually is considered unfavorable, steady improvement followed the application of electricity, although the facial muscles did not respond for some time to the current. In this case an abscess had formed over the mastoid process. This was incised and a sinus found, with the probe, leading down to the antrum and tympanum. Such abscesses behind the auricle are observed frequently in children who are strumous or tuberculous, and the disease in some cases is more marked in the antrum than in the middle ear itself. In young children, as previously mentioned, the different portions of the temporal bone are not united except by fibrous tissue, so that purulent secretion easily may force its way through, especially as the outer wall of the antrum is particularly thin. The pus escapes through a carious opening in the external wall of the antrum or else through the masto-squamosal suture, and as the periosteum is not so firmly adherent in a direction upward over the squamous portion as downward toward the tip, the subperiosteal abscess generally is situated above and behind the auricle, the latter standing out prominently. As such an abscess is seen more frequently in cachectic subjects than in those who are healthy, there is likely to be extensive caries, not only of the mastoid antrum, but also of the squamous portion of the temporal bone. In an infant operated upon but a short time since, there was a large subperiosteal abscess with extensive caries extending to the middle cranial fossa. The pus had undoubtedly burst through the antrum while the drumhead was not even perforated and but slightly congested, showing that the disease was confined to the antrum. The surgeon should always in such cases, after making a free incision in the soft parts, make a thorough examination with the probe for carious bone, and in most cases it will be found.

Some portions of the temporal bone are attacked more frequently by caries and necrosis than others. The different portions are involved usually in the following order: 1. The mastoid process. 2. The antrum and tympanic roof. 3. The bony wall of the tympanum covering the sigmoid sinus. 4. The posterior bony wall of the external meatus. 5. The floor of the tympanum, including the posterior wall of the canal for the carotid artery. Lastly, the petrous portion, including the bony labyrinth.

Skiagraphy is now being extensively used for the purpose of determining whether or not the mastoid is involved, and to what extent. This method of examination has proved useful in cases where the clinical symptoms are insufficient for a positive diagnosis of mastoiditis, and is particularly applicable to those cases of furunculosis which simulate mastoid involvement, and to cases of mastoiditis due to the streptococcus mucosus capsulatus, which at a certain stage may present, few if any, clinical symptoms. It gives us advance information of the character of the bone, whether it is of a pneumatic or diploëtic type or a combination—the arrangement of the cells; the location of the sinus in the majority of instances, whether it is near the surface or covered with cells, and it will frequently show the size and location of the mastoid emissary vein and its diverticula if any are present.

A series of *x*-ray plates may be of great value in showing an increasing cloudiness due to an empyema or intense inflammation, or the skiagraphs of the mastoid process may become gradually clearer and this indicate a resolving mastoiditis.

The various micro-organisms found in the mastoid antrum reach this cavity, as a rule, by means of the Eustachian tube. It is possible, however, for a purulent discharge in the ear to escape into the nasopharynx and reaching the lungs cause a pneumonia; or, if swallowed, the patient may have a foul-smelling diarrhœa. The streptococcus pyogenes and the staphylococcus aureus are frequently found, not only in the purulent secretion from the middle ear, but also in cases of brain-abscess, suppurative leptomeningitis, and thrombosis of the sigmoid sinus, especially when the thrombus has become disintegrated. Occasionally one discovers the presence of the staphylococcus pyogenes albus and citreus, the bacillus pyogenes fœtidus, and the diplococcus pneumoniæ of Fränkel. According to my experience, when streptococci are present the inflammation is apt to be of a severe type and to resist the ordinary treatment, while complications are likely to follow. In a case recently seen in consultation the acute otitis media followed an attack of tonsillitis. Both mastoid processes were involved, and the sigmoid sinus was thrombosed on the right side. Streptococci were found in the discharge. The case terminated fatally.

It is advisable to examine microscopically the pus from the tympanum, and to have cultures made, since much information can be obtained in this way as to the probable severity of the disease and as to the prognosis. A short time ago a patient was under my care who had an acute purulent otitis media in consequence of an acute nasopharyngeal catarrh. As there was considerable prostration, which was out of all proportion to the symptoms, the temperature being but slightly above 99° F., a culture was made and the Klebs-Löffler bacillus was found. On the following day a fibrinous cast was discharged from the tympanum through the perforation.

Since 1902 it has been the routine practice at the New York Eye and Ear Infirmary to examine smear preparations in every case admitted, to obtain an idea of the nature of the infection. Dr. Dixon reports that during eleven years there have been 5496 such examinations made, a small proportion being cultivated in unusually interesting and doubtful cases. Of these, 26.6 per cent. have been mixed infection, that is to say, a large number of mixed germs were present, and it was not advisable to charge the infection to any particular germ. The majority of these were chronic cases. and where the radical mastoid operation was performed the mastoid pus showed mixed germs as a rule. Streptococcus occurred as the predominating germ in 24.8 per cent.; pneumococcus, 12.2 per cent.; staphylococcus (aureus and albus), 7.4 per cent.; streptococcus mucosus capsulatus, 4.8 per cent.; the bacillus of Vincent in 1.8 per cent. The remaining 22.4 per cent. were represented by miscellaneous, negative, etc., among which were placed the bacillus pyocyaneus, diphtheria, tubercle, coli communis, Friedländer, etc.

The discrepancy as to the frequency of appearance of these various forms of infection as compared with the reports of other workers is only apparent, and is largely accounted for by the fact that no distinction has been made between acute and chronic suppurative otitis and their complications.

Dixon states that the pus taken for examination from the external auditory canal usually presents a mixed infection—that is, various micro-organisms; but generally the predominant germ is found in the mastoid cells, the sigmoid sinus, or brain itself, when these regions are secondarily involved. For instance, the streptococcus is found frequently in pure culture in cases of infective sinus thrombosis, while the micro-organisms from the auditory canal may be of the mixed variety. If the streptococcus and the pneumococcus are present in the external auditory canal, one generally finds these organisms associated in the more deeply seated suppurations, the other micro-organisms which may have been present in the discharge from the canal having disappeared.

Dixon maintains that the streptococcus mucosus capsulatus is the most insidious germ the otologist has to combat—one likely to be found in cases complicated with diabetes, especially in the aged. The early stage is much the same as any other severe infection of the middle ear or mastoid, and if vigorous treatment is resorted to early the results are equally good; but after paracentesis in a certain number of cases, the very acute symptoms, pain, tenderness, etc., disappear, the pulse and temperature become normal and remain so, and resolution seems assured, *but the discharge generally persists.* When this condition continues for from three to six weeks there is invariably extensive bone destruction. In the majority of such cases the mastoid cells are soft, and can easily be removed with a curette; not infrequently the dura is exposed. He insists that, in cases of this nature, if the discharge persists, and this germ can be demonstrated in the pus, an exploratory operation should be undertaken, even in the face of otherwise apparently normal conditions, so far as pain, tenderness, temperature, and pulse-rate are concerned, and that every day's delay after two weeks from the onset of the disease increases the danger of grave complications. The polynuclear count may or may not be increased. It has been observed in the laboratory of the New York Eye and Ear Infirmary that in most cases of mastoiditis complicated by diabetes the streptococcus mucosus capsulatus has been found in the discharge from the middle ear.

I recently reported fifteen cases of mastoid disease due to the streptococcus mucosus capsulatus, four of which were private patients and the others hospital cases. A mastoid operation was necessary in all of the cases except one of the private patients. Some of the patients complained of slight pain, while in others it was very severe, but there was extensive destruction of the mastoid cells in all the cases that came to operation, particularly in those in the hospital wards. There was both a perisinous and an epidural abscess in seven of the eleven hospital cases and in two others the dura was exposed. In two of the private cases, also, the dura was exposed. The *x*-ray is a most valuable aid in deciding as to the advisability of an operation. If a mastoid, which was previously shown to be cloudy, begins to clear up, and the symptoms show a steady improvement, I feel that we can afford to wait if the patient is carefully watched, and if a sufficient number of *x*-ray plates are taken. Such was the method persued in the case of the private patient who escaped operation. If, on the other hand, a patient is under treatment, and the discharge persists while all tenderness on pressure over the bone has disappeared, it is more than likely that a destructive process is going on in the mastoid cells and one is likely to find an exposed dura and sinus, particularly if the condition continues for from three to six weeks. A blood count is generally of little value. We should err on the safe side and operate when in doubt, for we often find a great destruction of bone, even in cases that present few symptoms. It is in only a few cases, which yield readily to treatment, that an operation can be avoided.

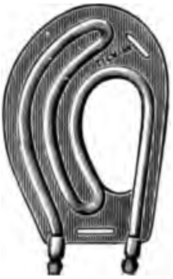
Two cases of acute suppurative otitis media came under my care in which the inflammation was due to the presence of the bacillus pyocyaneus in the tympanum. One patient was a child, six years of age, who had a cold, followed by bronchitis and acute otitis media. There was but slight discharge from the tympanic cavity, and it became necessary to open the mastoid cells, which were much involved. The other case was an adult, who had an attack of influenza and acute inflammation of the middle ear. The auditory canal became very much inflamed and constricted, and the auricle was very tender to the touch. The mastoid process was sensitive to pressure but an operation was not required.

Prognosis. The prognosis is generally favorable in a simple, uncomplicated case if the disease is of recent origin. When occurring in connection with influenza, typhus fever, scarlatina, measles, tuberculosis, and diphtheria, on account of the rapid destruction of bone which frequently takes place, the prognosis becomes more grave, particularly if the disease has existed for a long time. In ten days' time, particularly if the patient has diphtheria, scarlet fever, or influenza, the entire mastoid process may be filled with pus, and present a carious opening into the posterior or middle fossa. Frequently in cases of mastoiditis where streptococci are present the surgeon will find the sigmoid sinus embedded in pus and granulations even when the disease has existed for a short time and the symptoms have not been indicative of gravity. It is not always possible to tell whether the brain or the sigmoid sinus is implicated before the operation is performed, so that until the condition of the mastoid cells has been investigated the surgeon should be guarded as to the prognosis.

When acute mastoiditis occurs as a complication of measles, even though the case apparently be a mild one, the surgeon should be very cautious about giving a favorable prognosis. In the author's experience meningitis has suddenly developed in a number of cases where the operation was performed early and all the symptoms seemed favorable.

Treatment. If the surgeon is fortunate enough to see a case of acute inflammation of the mastoid cells in the first stage before pus has formed, the patient should be put immediately to bed and kept very quiet, and should be given a very light diet, consisting principally of milk. Calomel should be administered in $\frac{1}{10}$ to $\frac{1}{4}$ grain tablets, one every hour for six doses, or until a laxative effect has been produced. Tincture of aconite, in one drop doses, is also an excellent remedy in the early stage. The artificial leech should be applied at once in two or more places on the mastoid bone, and especially just over the antrum and over the tip. It is advisable at the same time to make a *free incision in the drumhead* (see Fig. 81), along its posterior border from a point nearly opposite the stapes down to the lowest point of the membrane, especially if there is fluid within the tympanic cavity. In some cases the surgeon should prolong the incision up to the posterior fold of the drumhead and through the tissues into the attic, and then carry the incision along the posterior and upper wall of the external auditory canal. For this purpose a large knife should be used (see Fig. 80), and at the location just mentioned, in order to drain the attic and antrum if possible. The day has gone by for using a small paracentesis needle. After the patient has been put to bed the Leiter coil (see Fig. 141) should be adjusted and kept in place for *from thirty-six to forty-eight hours, but never longer than this.* The cold generally relieves the pain at once, but if left on for too long a time it may mask other important symptoms. Cold should under no circumstances be applied *except in the first or hyperæmic stage, and should never be re-applied* after having been removed. The coil consists of a malleable plate which can be so moulded as to fit any mastoid process. Ice-water, by the siphon principle, passes through this coil by means of rubber tubing

Fig. 141.



Leiter coil.

reappears. This is probably due to the fact that a focus of infection has remained in the tympanum, and in such cases a mastoid operation is frequently required.

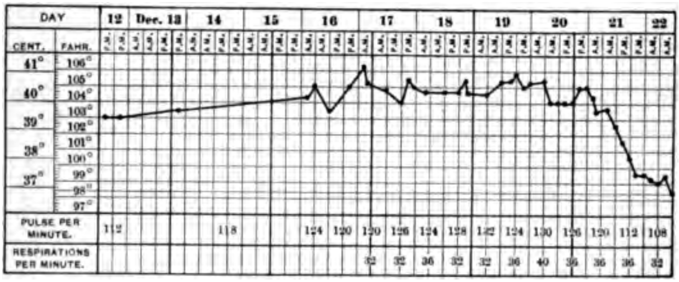
Acute inflammation of the mastoid cells may terminate in recovery without the formation of an abscess, but more frequently suppuration occurs and carious destruction of the bone results, so that after weeks of suffering a large sequestrum may be found. In influenza cases rapid destruction of bone is the rule, so that it is imperative in such to open the cells very early. The pus may force its way through the tympanic roof, and give rise to meningitis or brain-abscess, or may cause destruction of the thin plate of bone covering the sigmoid sinus and produce thrombosis, or perforation may take place at the mastoid tip (Bezold), thus allowing the septic matter to burrow beneath the deep fascia, and give rise to septicæmia and pyæmia, or to a postpharyngeal abscess.

In the pneumatic mastoid process, where the cells are large and the outer cortex thin, the pus is more likely to force a passage externally and form a subperiosteal abscess than in the diploëtic and sclerosed processes. In the latter, according to my experience, the tendency is for the pus to escape through a carious opening in the tympanic roof, and to give rise to an extradural abscess or an abscess in the brain-substance itself.

Facial paralysis is observed in some instances as a result of disease of the mastoid process itself as well as of injury inflicted by the surgeon during an operation. In a child, one and one-half years of age, in whom facial paralysis made its appearance before operation, the mastoid cells were found extensively diseased, so that it was necessary to remove bone in all directions. Although the prognosis as to recovery from the paralysis in such cases usually is considered unfavorable, steady improvement followed the application of electricity, although the facial muscles did not respond for some time to the current. In this case an abscess had formed over the mastoid process. This was incised and a sinus found, with the probe, leading down to the antrum and tympanum. Such abscesses behind the auricle are observed frequently in children who are strumous or tuberculous, and the disease in some cases is more marked in the antrum than in the middle ear itself. In young children, as previously mentioned, the different portions of the temporal bone are not united except by fibrous tissue, so that purulent secretion easily may force its way through, especially as the outer wall of the antrum is particularly thin. The pus escapes through a carious opening in the external wall of the antrum or else through the masto-squamosal suture, and as the periosteum is not so firmly adherent in a direction upward over the squamous portion as downward toward the tip, the subperiosteal abscess generally is situated above and behind the auricle, the latter standing out prominently. As such an abscess is seen more frequently in cachectic subjects than in those who are healthy, there is likely to be extensive caries, not only of the mastoid antrum, but also of the squamous portion of the temporal bone. In an infant operated upon but a short time since, there was a large subperiosteal abscess with extensive caries extending to the middle cranial fossa. The pus had undoubtedly burst through the antrum while the drumhead was not even perforated and but slightly congested, showing that the disease was confined to the antrum. The surgeon should always in such cases, ture suddenly rose to 104° F. There were inflammation and bulging of both drumheads, together with tenderness on pressure over the antrum and lower third of the mastoid process on each side. Incision of each drumhead and application of the Leiter coil, with frequent syringing of the auditory canals, was the treatment employed. After incising the membranæ tympani the temperature fell to 100° F. The patient recovered without operation.

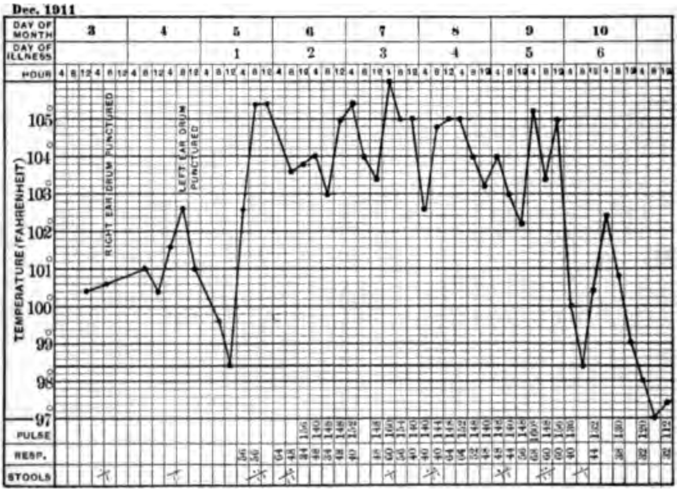
In a child of eleven, who had an attack of grippe and tonsillitis, followed by earache on the left side and inflammation of the mastoid process, the temperature was 103° F. There was a sticky discharge from the canal two days later, which gave some relief to the patient. This was but temporary, however, for on the following day she vomited and had a return of the earache. She was seen by the author in consultation on the next day, and at that time there was tenderness on pressure over the middle and lower thirds of the mastoid. There was some sticky sanious discharge from the left auditory canal, with bulging of Shrapnell's membrane. There seemed to be a small perforation in the membrana flaccida, and also one in the anterior inferior quadrant of the drumhead. In spite of the treatment, which consisted in the application of leeches, incision of the drumhead, and the use of the ice-bag (see Fig. 144), the mastoid symptoms became more marked, and twenty-four hours later the temperature rose to 106.2° F. It was necessary to open immediately the mastoid cells and remove granulations and softened bone. The temperature varied from 104° to 105.8° F. At this time evidences of pneumonia on the left side were first discovered, in spite of the fact that a careful examination of the chest had been made each day. Two days later

FIG. 142.



Temperature chart of a case of acute otitis media followed by acute mastoiditis, complicated with pneumonia.

FIG. 143.

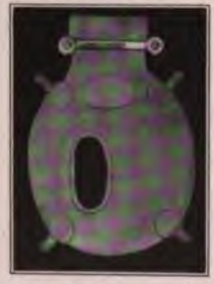


A case of acute suppurative otitis media, complicated by pneumonia.

the temperature began to decline gradually, and perfect recovery followed (Fig. 142).

A particularly interesting case, seen in consultation, was the following: An infant, under a year, had a severe cold, and both drumheads were incised by an otologist, and there was a discharge from each ear. The temperature, nevertheless, remained high (Fig. 143). Several other consultants were then called in to examine the child. The patient seemed very ill, with a steady high temperature, but nothing could be found in the chest or elsewhere to account for the fever. The attending otologist and myself did not believe the case to be one of sinus thrombosis, as the clinical symptoms were not characteristic. After four days' time pneumonia was first detected by a physical examination of the chest, although a careful examination had been made each day previously.

FIG. 144.



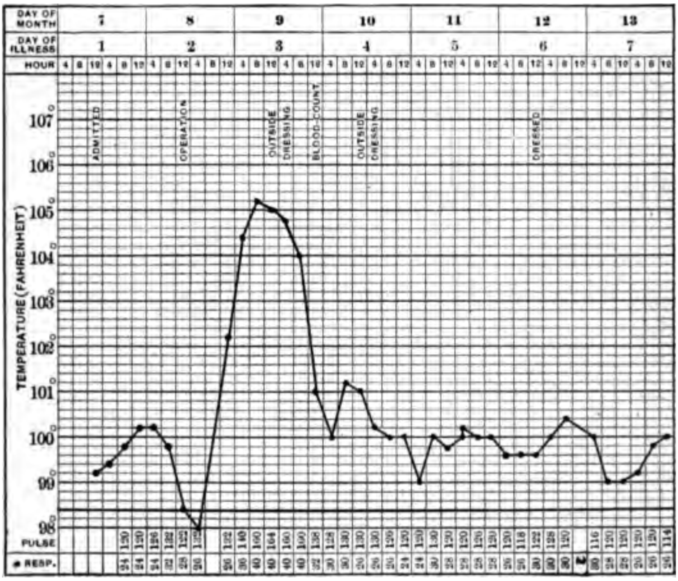
Sprague's ice-bag for application over the mastoid process.

Other cases, similar to the preceding one, have come under the care of the writer, in which the first symptom was a severe earache, usually following an attack of influenza. An important diagnostic point is the presence usually of the pneumococcus in the discharge from the ear, and the fact that the temperature is very much elevated and does not show the sudden variations which are characteristic of infective sinus thrombosis. A steady high temperature is observed sometimes in sinus thrombosis, and in some cases of pneumonia, especially in children, the temperature, instead of remaining high as it usually does, will show marked variations, and simulate a case of sinus thrombosis (see Fig. 181). It is extremely difficult to detect the pneumonia at first, on account of the consolidation being probably deep-seated. When the physical signs are well marked, the discharge from the ear is apt to become scanty, but later, when convalescence has been established, the otorrhœa may again be profuse. It is especially important in all cases in which pneumonia is suspected to avoid giving an anæsthetic, and particularly ether. When the temperature remains elevated after the mastoid cells have been opened, one can be fairly confident that some complication exists, possibly a pneumonia, or thrombosis of the sigmoid sinus, or other intracranial disease or erysipelas. There are cases of mastoiditis, however, in which the temperature remains high after operation, and in which the cause is due undoubtedly to septic absorption. This is especially the case where pus has been found in the mastoid cells, and where the temperature has been considerably elevated some days before the operation. I have several times been inclined to perform some further operation in certain cases in which the temperature did not come down soon after opening the mastoid cells. It is always advisable to abstain from administering antipyretics in cases of mastoid disease or other complications, because it is most important for the surgeon to make a diagnosis at a very early stage, and to operate immediately in case of a brain complication, if he wishes to meet with success. If it is desirable to reduce the temperature, it is better, especially in the case of children, to resort to sponging the body with alcohol and water. If the rise in temperature is due to the presence of pus, it is important for the surgeon to find this out as soon as possible.

In very young infants, after an operation on the mastoid antrum, the temperature is apt to rise to 105° or 106° F. It gradually falls, however, and one should not be alarmed at its occurrence, for it happens frequently with my cases. One must never forget that a child is liable to have a high temperature from a very slight cause. The following case will illustrate this point: Nancy V., three months old, was admitted to my service at the Infirmary with a subperiosteal abscess over the mastoid process. The mother said that there had been a swelling there for five weeks, and that two weeks ago her family physician made an incision in the abscess. The wound drained well for one week, and then it reappeared and increased in size very rapidly. As a result the child did not sleep, cried a great deal, and was very fretful. There was no discharge from the ear. Under an anæsthetic the abscess was opened. There was a carious opening in the bone just over the site of the antrum. This was enlarged, and all softened bone and granulations were removed from the antrum and rudimentary cells. The dura was exposed to quite an extent. The infection was due to the staphylococcus. On the day following the operation the temperature rose to 105.2° F., but on the succeeding day fell to 100° F., and the child made a good recovery (Fig. 145).

During dentition children are very apt to have attacks of acute suppurative otitis media, and occasionally the mastoid process becomes secondarily involved. In a case[1] of acute suppurative otitis media, which was characterized by high temperature and symptoms of brain implication, and in which it was necessary to remove

FIG. 145.



Sharp rise in temperature after a mastoid operation in an infant.

carious bone from the mastoid antrum, the patient recovered, but the causation of the high fever was most obscure until four molar teeth made their appearance.

Inflammation of the mastoid cells may follow an unskilful attempt at removing adenoid vegetations.

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[1] Bacon: Annals of Ophthalmology and Otology, Jan., 1894, vol. iii. No. 1.

Such a case came under my observation, and it is surprising that similar instances are not more frequent, when one considers how roughly the operation is occasionally performed, and how often the orifices of the Eustachian tubes must be lacerated. The case reported[1] was that of a woman, twenty-four years of age, who complained of a sore throat. She was told by her physician that she had adenoids, and on the following day he excised the growths. She soon afterward had an attack of earache, followed by mastoid inflammation. This case illustrates two most important points: first, that all operations should be done with as much gentleness and skill as possible; and, secondly, that an operation for the removal of adenoids should never be undertaken until all acute symptoms have subsided.

Of late years otologists have reported cases of *Osteomyelitis* as if the disease were entirely distinct from an ordinary suppurative inflammation of the mastoid cells. According to Dr. E. H. Nichols, of the Harvard Medical school, "infective osteomyelitis is an acute suppurative inflammation of the bone and may be produced by any one of a variety of pathogenic microörganisms or by a mixed infection". Osteomyelitis should simply be considered a severe type of bone inflammation and due generally to the presence of the staphylococcus or streptococcus, particularly the latter. Knapp[2] says "that osteomyelitis exists only in the diploic variety of the mastoid process," and he reports a case where the disease extended to the occipital bone with disseminate abscesses in the bone and under the deep muscles of the neck. Two operations were performed, resulting in total resection of the mastoid and removal of a carious piece of the occipital bone with exposure of the cerebellar dura. The case did not recover for months. The disease is found more frequently among the young and it is possible that the changes in the bone of young children may have something to do with the development of the disease. It is well-known that, in infants and young children, myelin cells are present in the soft parts of the bone in considerable quantity, only to become very much less numerous as the child grows until finally in the adult there are but few myelin cells except in the long bones, the sternum and the vertebræ. The patient seems to suffer from profound intoxication with marked general depression and usually has a high temperature. The area of tenderness over the mastoid bone is extensive and œdema is apt to appear at an early stage. When an operation is performed the suppurative inflammation will be found to extend over a greater area than is usual, involving in some instances the occipital and parietal bones. Even after all diseased bone has been removed at the time, the surgeon may, at a subsequent operation, find that the disease of the bone has extended in various directions. The author has operated on a number of these cases and when occurring as a complication of measles, osteomyelitis is quite likely to be followed by meningitis.

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[1] Bacon: Transactions of the American Otological Society, 1892.

[2] Archives of Otology, vol. xxxii, No. 6.

It is important in this connection to refer to a complication that is an extremely infrequent one, viz., the so-called *white erysipelas* affecting the scalp. In the case[1] of a young woman who had an acute suppurative otitis media followed by mastoid disease, the cells were opened and the entire bony contents removed with granulations. The temperature, instead of falling, gradually became higher, reaching 104.4° F. Later the patient had a chill lasting twenty minutes, and vomited. It was noticed that the scalp near the wound was œdematous, tender to pressure, but not pinkish in color. The tenderness and œdema gradually extended over the scalp, while the discharge from the ear and wound was much diminished in quantity. The temperature in a few days became normal, and the patient made an excellent recovery. Another point of interest in the case was the fact that before the operation the urine was found to contain a large amount of sugar, which disappeared, however, before the patient left the hospital. Several urinary examinations were made afterward, but no sugar was found. The case before the erysipelas developed presented symptoms characteristic of septic absorption. The so-called white erysipelas has been known to affect the eyelids, the scrotum, the prepuce, the vulva, and the inferior extremities of persons enfeebled by disease. The glycosuria seemed to be of nervous origin and due to reflex action.

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[1] Bacon: Revue de Laryngologie, d'Otologie, et de Rhinologie, 1895, No. 8.

Indications for Operation. It is undoubtedly true that some cases of simple, uncomplicated inflammation of the mastoid cells recover spontaneously if left to nature, while, on the other hand, it should not be forgotten that lives have been sacrificed because the operation of opening the cells had been deferred too long. As the operation is a comparatively safe procedure if performed under aseptic conditions, I think that where the surgeon is at all in doubt he should always err on the safe side and open the cells at once. I would not, however, be understood to make light of the operation of perforating the mastoid, because it should never be undertaken by one who does not thoroughly understand the anatomy of the temporal bone, and who has not had considerable experience in treating aural diseases.

If, under the use of antiphlogistic measures and the Leiter coil, the pain rapidly subsides, while the discharge becomes less and the symptoms generally improve in a few days, the temperature showing no evidence of septic absorption, the chances are that an operation will not be necessary. On the other hand, if the pain persists and the temperature remains high after the appearance of the discharge, and especially if the latter is profuse, and inspection of the drumhead shows it to be bulging in its upper and posterior quadrant, with drooping of the adjacent soft tissues of the external meatus, and, moreover, if there is considerable deafness with pain on pressure over the mastoid process, these symptoms taken together should cause the surgeon to decide upon an immediate operation.

If the pain on pressure over the mastoid bone reappears in several days after it has fully subsided, it is a very unfavorable symptom, and usually means that a mastoid operation is inevitable.

It is not safe to delay operation in cases of mastoid disease caused by the influenza, scarlatina, measles, diphtheria, or where there are streptococci and pneumococci (either Sternberg's or Friedländer's) present in large numbers in the discharge from the ear. Experience has shown that complete destruction of the bony cells and perforation of the inner wall may take place in such cases in an incredibly short time, without the usual well-marked symptoms of mastoid disease. In a patient, fifty years of age, who was under observation a short time ago, and who had been treated for two weeks for an acute purulent otitis media, with tenderness over the mastoid cells, it was deemed best to open the cells, owing to the fact that there was a profuse discharge, which did not yield to treatment, as well as a temperature slightly above normal, which persisted, and tenderness on pressure just over the apex of the mastoid. In this case the cells were entirely destroyed, and there was a large carious opening over the lateral sinus. The patient was up and about, and did not complain of pain in the mastoid except when firm pressure was made over the tip. This latter symptom is a most valuable one, and should never be lost sight of in arriving at a diagnosis. Undoubtedly, in the near future, otologists will be more ready than ever to make cultures from the pus in purulent otitis media, for considerable information can be obtained in this way as to the prognosis and treatment. Examination of the blood is also of great value, especially when the surgeon is in doubt about operating. An increased leucocytosis with the polynuclear elements considerably above the normal will often decide one to operate at once. An increase in the polynuclear elements is especially significant.

In a report of forty cases[1] of acute purulent otitis media, complicated by acute inflammation of the mastoid cells occurring in my private practice, it was necessary to perform a radical mastoid operation in ten instances. In two of these operative cases a subsequent operation for sinus thrombosis was performed, one terminating fatally. This was the only case of death among these forty cases. *In thirty cases, or 75 per cent., the mastoid cells were not opened.* The ages of the forty patients varied from six to sixty-five years. There were twenty children under fifteen years, and of this number sixteen were males and four females, while of the remaining twenty adults, ten were males and ten females. The cases which recovered without operation were treated in the manner already described, viz., by means of the artificial leech, the Leiter coil, and by making a free incision in the drumhead. This conservative line of treatment should never be carried out for any length of time except by one who has had considerable experience in treating aural diseases, and who can recognize very early the more serious symptoms so characteristic of mastoid disease. The aural surgeon should be in close touch with the patient, and if he does not see him each day, he should be in a position to know his exact condition, so that he may operate at a moment's notice in case of necessity. The surgeon should make every effort to cure his patient without opening the mastoid cells. If, however, the latter operation becomes necessary, he should not hesitate for a moment, not only to remove all diseased tissues from the mastoid antrum down to the tip, but he should be fully competent and prepared to operate at all times for any intracranial complication.

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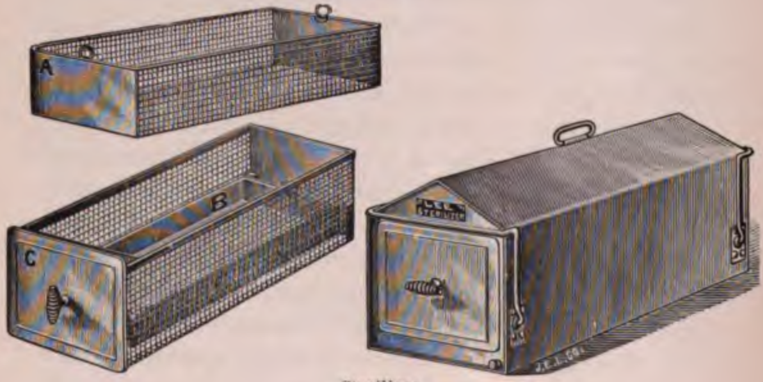
[1] Bacon: "Non-operative Cases of Acute Inflammation of the Mastoid Cells," Archives of Otology, 1901, vol. xxx, No. 1.

Operation. Before undertaking an operation either for mastoid disease or one of the complications arising from it, the surgeon should first of all find out about the patient's general condition. A thorough urinary analysis should be made and the patient's heart and lungs should be examined. On the day of the operation the patient should have nothing but liquid food, and even this should be forbidden for at least five hours before taking the anæsthetic. If possible, a laxative should be administered the evening before, followed by some mineral water in the morning.

Ether is to be preferred, on account of its being a safer anæsthetic than chloroform. In short operations, however, chloroform may be used if carefully administered. The ether should be given by a thoroughly competent assistant, who should attend to this duty alone, and thus relieve the surgeon of this anxiety.

FIG. 146.

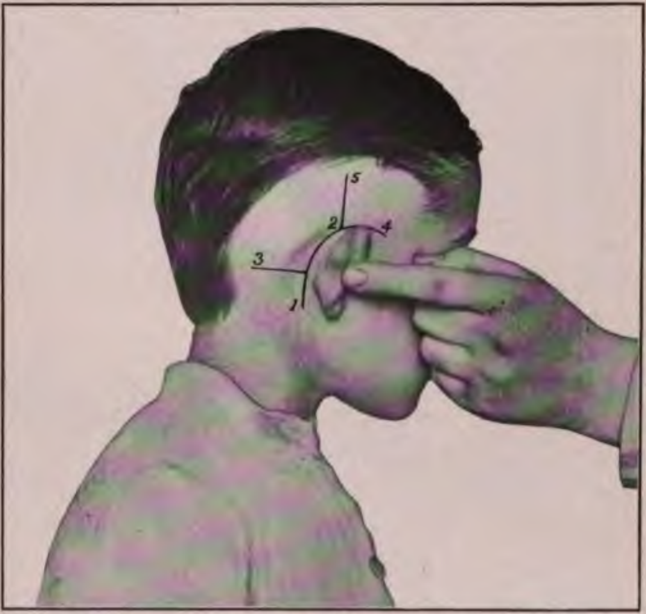


Sterilizer.

On account of the disagreeable sensations caused by the inhalation of ether, it is well to give nitrous oxide gas at first, and then change to ether. An excellent apparatus (Bennett's inhaler) has been devised for this purpose, and may be obtained of the instrument-makers.

All instruments should be sterilized thoroughly, and for this purpose the sterilizer shown in Fig. 146 is a very convenient one. The blades of the scalpels should be dipped in a boiling 5 per cent. carbolic solution or in absolute alcohol. The hands of the operator and of his assistants should be scrubbed thoroughly with green soap and water by means of a nail-brush, and afterward washed

FIG. 147.

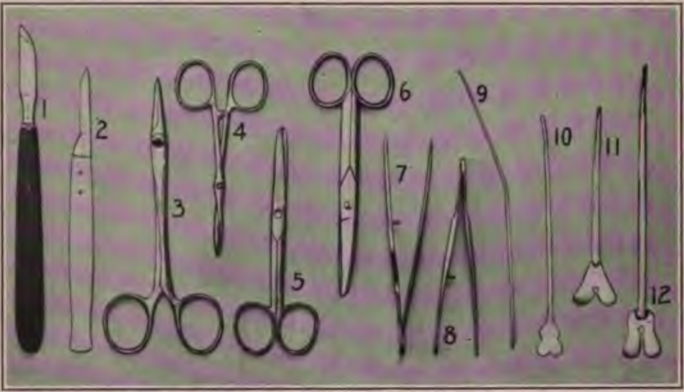


Lines of incision made in operations for mastoiditis, sinus thrombosis, and brain abscess. From point 1 to point 2, incision for mastoid operation. Incision extended from 2 to 4 and from 2 to 5 in operation for brain abscess. Incision from original line for mastoid operation to point 3 in operation for sinus thrombosis.

with a bichloride solution, 1 : 3000. Of late years I have used sterile rubber gloves for all operations.

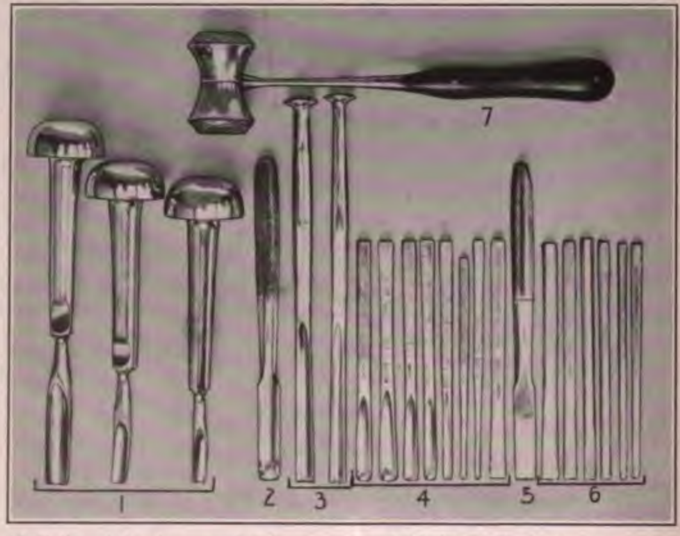
The instruments used in a mastoid operation are the following: one narrow and one broad scalpel, artery

FIG. 148.



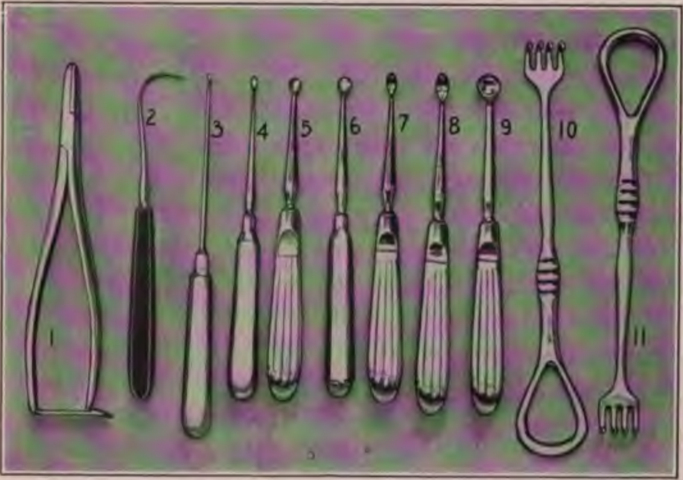
1, 2, scalpels; 3, Halsted's artery forceps; 4, small French artery forceps; 5, straight scissors; 6, curved scissors; 7, 8, dressing forceps; 9, 10, probes; 11, 12, grooved directors.

FIG. 149.



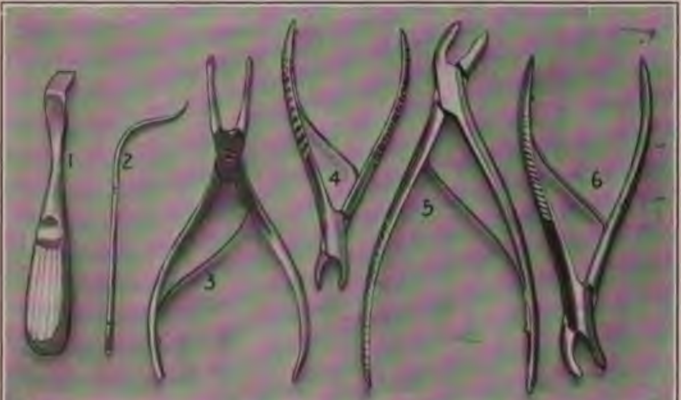
1, Ballance's hand gouges; 2, 5, large gouge and chisel; 3, Ballance's long gouges; 4, 6, Schwartze's gouges and chisels; 7, mallet with lead filling.

FIG. 150.



1, McBurney's needle holder; 2, aneurism needle for ligating internal jugular vein; 3 to 9, sharp spoons, different sizes; 10, 11, retractors.

FIG. 151.

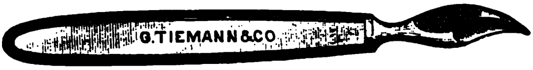


1. periosteum elevator; 2. Stacke's protector; 3. Jansen's rongeur forceps; 4, 6, rongeur forceps; 5, author's rongeur forceps.

forceps, periosteal elevator, dressing-forceps, gouges and chisels, a mallet, rongeur forceps, sharp spoons (seven sizes), retractors, grooved directors, probes, catgut ligatures, needles, and sutures.

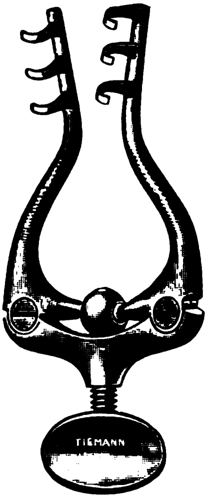
The hair of the patient should be shaved within a radius of about two and a half inches (Fig. 147) of the auricle. The parts thus shaved should be scrubbed with soap and water, and afterward washed with a solution of bichloride of mercury, 1 : 3000. The external meatus should be syringed with a warm bichloride solution, then dried and filled with a narrow strip of iodoform gauze. The head should be wrapped with a sterile towel and fastened with a safety-pin. Similar towels should be laid over the patient's face, neck, and shoulders and only the region to be operated on should be exposed. After these precautions have been taken, the auricle being gently pulled forward by an assistant, an incision should be made by the surgeon, just behind and close to the auricle (from point 1 to point 2, Fig. 147), from the extreme tip of the mastoid to a point just above the upper border of the auricle. The soft parts and periosteum should be divided with a Politzer periosteal knife (Fig. 152), and the latter pushed aside by means of the periosteal elevator. The soft parts should be separated with retractors held by an assistant, or Jansen's retractor can be used. Hemorrhage should be controlled by means of the artery clamps and by pressure. Dry

FIG. 152.



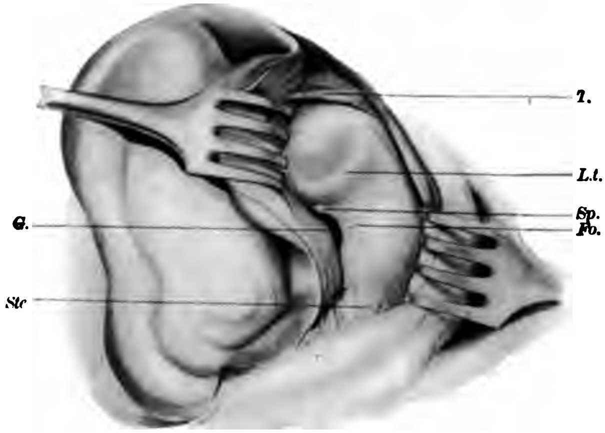
Politzer periosteal knife.

FIG. 153.



Jansen's mastoid retractor.

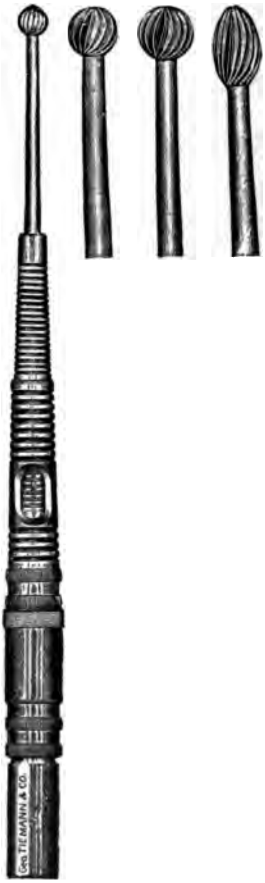
FIG. 154.



Integument and periosteum removed from mastoid process. (Gerber.) *T.*, Temporal muscle. *L.t.* Linea temporalis. *Sp.* Spina supra meatum. *Fo.* Temporal fossa. *G.* External auditory canal. *Ste.* Tendon of Sterno-cleido-mastoid muscle.

sterile gauze cut in strips makes the best and most satisfactory sponges. The entire surface of the bone should then be examined carefully for a carious spot or sinus, and, if found, an opening at that point should be made into the cells by means of a gouge and mallet. A large gouge should be used at first, and all the diseased bone carefully removed with sharp spoons. The surgeon should endeavor to reach the antrum, knowing that the latter is just above and behind the external meatus. Great care should be taken in scraping the antrum, for fear of injuring the facial nerve. Macewen uses burrs (Fig. 155), which can be rotated by means of an electric motor (Fig. 37). He prefers them to chisels and gouges. They are excellent instruments when carefully handled; but when considerable bone is to be removed and the operation is to be performed as quickly as possible, the surgeon can work more rapidly with chisels, gouges, and rongeur forceps.

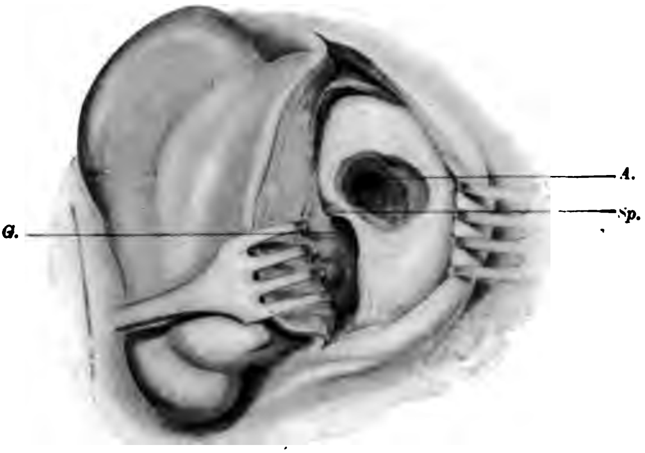
FIG. 155.



Macewen's burrs.

If there is no sinus evident, nor a soft spot of bone, the surgeon should first chisel an opening into the antrum and establish communication with the tympanum. A guide for this operation is the spina suprameatum, a point about one-quarter of an inch below the linea temporalis. The bone should be removed at a point about one-eighth inch behind the spine and the instrument directed downward, forward, and inward, in order to reach the antrum. The entire external wall of the antrum should be removed. Small pieces of bone should be cut away at a time, and the parts carefully inspected by means of good illumination. A probe or director should be used constantly to see if an opening has been made into the antrum. The sharp spoon will also be found very useful in this step of the operation. As a rule, the

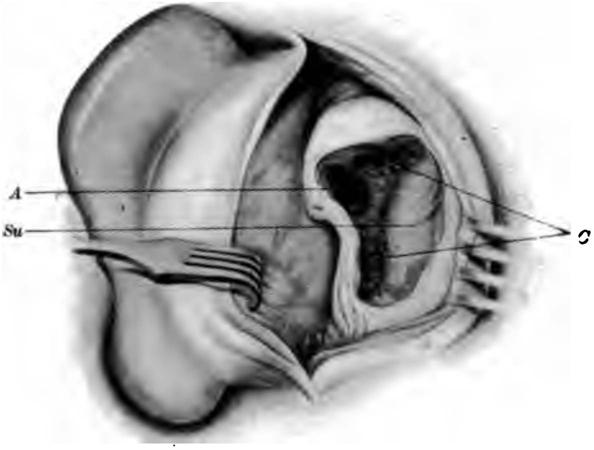
FIG. 156.



Opening of the antrum in simple empyema (Gerber). *A.* Mastoid antrum *Sp.* Suprameatal spine. *G.* External auditory canal.

bone should not be entered at a depth greater than five-eighths or three-quarters of an inch, for fear of injuring the facial nerve or external semicircular canal. There is also danger of wounding the lateral sinus and dura mater in either the posterior or middle cranial fossa, unless one uses the chisels carefully and in the direction already mentioned. The opening in the bone should be cone-shaped from without inward. After establishing a communication with the antrum and attic, the surgeon should then turn his attention to the other portions of the mastoid, remembering that in some acute cases the pus is limited mostly to the middle portion, while in others it is found in the tip with granulations and softened bone. In

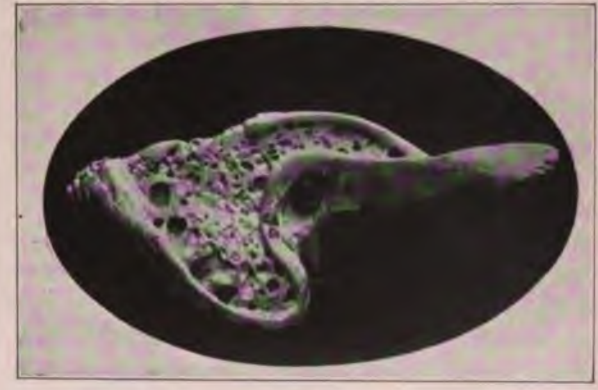
FIG. 157.



Removal of the mastoid cells completed (Gerber). *A*. Antrum. *Su*. Sigmoid groove. *C*. Few remaining mastoid cells.

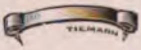
some instances the sigmoid sinus will be found exposed and bathed in pus and covered with granulations. Care should be taken, however, not to remove healthy granulations covering an exposed dura or sinus. Cases have been reported of sinus thrombosis which probably developed from inadvertent exposure of the sigmoid sinus during a mastoid operation—Kœrner explains this pyæmia from the irritation of the sinus by the introduction of gauze so that a parietal thrombus is formed, and he warns against exposing a normal sinus unnecessarily. In scraping away the granulations it is an easy matter to wound the sinus. A thorough examination should be made of the tip, to see if it is perforated, for in some cases pus may burrow down the neck beneath the deep fascia. If an abscess has already formed in the tissues just about and below the tip, it should be opened freely and the pus evacuated. The tympanic roof should be examined to see that a carious opening does not exist. The surgeon should be very particular to remove all diseased zygomatic cells for they extend very far forward in some temporal bones (Fig. 158). All softened bone, granulations, etc., should be removed thoroughly by means of sharp spoons, and the entire mastoid cavity thoroughly irrigated with a normal salt solution. The surgeon should be careful not to scrape away too much bone and thus make the inner wall of the cavity too smooth, for by so doing the nutrition of the bone is undoubtedly impaired. As a result the inner wall remains white for a time and granulations will be slow in appearing on its surface. If possible, the surgeon should try to force some of the solution through the antrum and the external meatus. A small perforation in the drumhead should be enlarged. The cavity in the bone should then be packed with narrow strips of sterile or a mild iodoform gauze, and afterward several sutures may be taken in the upper and lower angles of the wound, to diminish the size of the opening. Michel clamps (Figs. 159–161) can be used in place of sutures. Larger strips of sterile gauze should then be placed

FIG. 158.



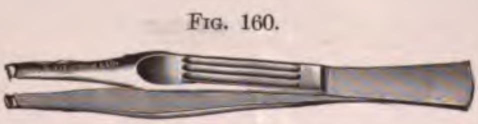
Temporal bone, showing pneumatic and diploëtic mastoid cells and many extensive zygomatic cells.

FIG. 159.



Michel clamp.

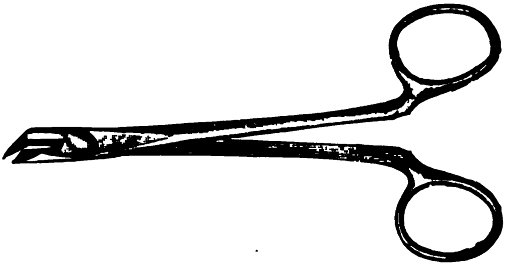
FIG. 160.



Forceps for applying Michel clamp.

about the ear, so as to cover the wound and the auricle, while the whole should be covered with a layer of absorbent cotton and bandaged. It is frequently advisable to change the outer dressings on the following day, if they have become saturated and stiffened so as to be uncomfortable to the patient. Unless the patient has more or less fever, with pain, the packing in the mastoid should be left in place for at least two or three days. If the gauze is left *in situ* too long, it may become adherent to the bone cavity, and cause bleeding when removed. To prevent this and to make the first dressing as painless as possible, some surgeons use a perforated piece of sterile rubber tissue which is inserted into the mastoid cavity and then filled with narrow strips of gauze so as to make equable pressure on all parts of the bony cavity. After the first dressing, boric acid or plain sterile gause should be substituted for the iodoform gauze, and thould be applied loosely, so as to allow the cavity to fill up as rapidly as possible with granulation tissue. In some cases it is better to continue the use of iodoform

FIG. 161.



Forceps for removing Michel clamp.

gauze especially if the granulations show a tendency to be pale and unhealthy. In the latter case the balsam of Peru should be poured into the wound before repacking it with gauze. Several days should elapse between the dressings, if possible, for frequent syringing has a tendency to prevent the granulations from growing. After the operation the patient usually experiences great relief, and the temperature, if elevated, becomes lower. The discharge from the ear is usually diminished in quantity or ceases altogether. The time before cicatrization takes place varies from four to eight weeks. It is longer frequently in cachectic or scrofulous individuals. If all of the carious bone has not been removed, a second operation becomes necessary. When granulations are exuberant they should be cauterized with a solid stick of nitrate of silver. When pale and flabby, a 25 per cent. solution of argyrol may be used to advantage. Silver drainage-tubes, iron nails, rubber tubing, etc., should never be used for purposes of drainage, for gauze is to be preferred.

In some cases, if the antrum has not been opened and there is no communication with the middle ear, and the disease is limited to the middle or lower third of the mastoid process, and especially if the inflammation occurs in a pneumatic mastoid process and is near the external surface, the surgeon may allow a blood-clot to form, and he may close with sutures the entire wound, provided, however, that every trace of disease has been removed with sharp spoons. If the patient complains of pain, or there is a rise of temperature, the wound should immediately be reopened and treated by packing it with gauze in the *usual way*.

I have occasionally performed a modified blood-clot operation, by scraping with a sharp spoon the healthy granulations which had formed and allowing the cavity to fill with blood. After freshening the edges of the wound they should be brought together and sutured. This method I have tried successfully in the Schwartze-Stacke operation, where the healing was slow.

The subcutaneous injection of autogenous vaccines is also of value, as it hastens the healing of the wound in many cases.

In the treatment of an abscess behind the auricle, frequently observed in the case of scrofulous children, it is not sufficient to make an incision and evacuate the pus, for it should be remembered that in all probability the purulent matter has forced its way either through the outer wall of the antrum or through the petroso-squamosal suture, and that in such a condition of affairs considerable carious bone undoubtedly exists. The child should be etherized and a long incision made behind the auricle close to the bone, and the condition of the antrum and cells carefully investigated.

Diet. After the operation it is desirable to keep the patient quiet in bed for a few days at least, until the temperature becomes normal and the patient feels inclined to sit up. While there is any elevation of temperature the diet should be a light one, consisting for the most part of milk and beef-tea. After a week's time, if the temperature is normal and the case progresses favorably, I frequently allow a hospital patient to go home and be treated as an out-patient, impressing upon him the importance of remaining in-doors during inclement weather.

Attention to the General Health. Particular attention should be paid to the general health, especially when the patient is cachectic or scrofulous. In the latter case cod-liver oil, iron, strychnine, or the hypophosphites are indicated, while syphilitic or tubercular subjects should have appropriate constitutional treatment. This is a subject of the greatest importance, for in many instances local treatment alone avails but little if attention to the general health is neglected.

MASTOID DISEASE OCCURRING IN CONNECTION WITH CHRONIC PURULENT OTITIS MEDIA.

Very often, during the course of chronic otorrhœa the ossicles become carious, while the antrum is apt to be filled with purulent material, and in some instances the entire antrum and mastoid process may contain cholesteatomatous masses, or there may be within the bony cavity cheesy matter, softened bone, granulations, or tubercular material. In other cases the mucous lining may be very much thickened, so that the cells are obliterated, while in still other instances the granulation-tissue contained in the cells may turn into bone, so that the mastoid process becomes wholly or in part changed into dense osseous tissue as hard as ivory (sclerosed mastoid). There may be a circumscribed caries of the mastoid process, or it may be very extensive, leading to various complications. For instance, a patient recently came to my clinic who had had a discharge from the ear for ten months. He complained of pain and tenderness over the mastoid process, especially the tip. A leech was applied, which gave some relief. He returned in a few days, when there were evidences of slight facial paralysis on the same side as the ear inflammation. He was admitted immediately to the hospital, and when placed under ether great destruction of bone was found, with the mastoid cells filled with pus and broken-down tissue. The lateral sinus was exposed, and there was a large carious opening in the tympanic roof. This was enlarged, and considerable pus escaped from the middle fossa. The boy recovered. This case goes to prove the statement previously made that a patient may have, with very few symptoms, extensive caries and necrosis of the mastoid process.

The most frequent cause of mastoid disease in connection with chronic purulent otitis media is interference with the drainage from the antrum or middle ear, so that pus collects in the mastoid process and forms caseous material. Constriction of the external meatus, the formation of polypi, granulations, a small perforation in the drumhead, suppuration limited to the attic with perforation in Shrapnell's membrane, and cholesteatomata, may cause mastoid disease. Various micro-organisms in the discharge from the middle ear, including tubercle bacilli, may give rise to mastoid inflammation. Other causes are cold, injury, and the various diseases mentioned in the etiology of acute mastoid disease.

Symptoms. The symptoms are similar to those mentioned in connection with acute mastoiditis, especially when occurring as a result of exposure to cold or retained secretion; but when eburnation of the bone takes place, this process may be gradual and extend over a period of years, so that there are few if any symptoms.

The external auditory canal frequently is found very much constricted and filled with retained secretion, the latter being foul-smelling and sanious, especially if granulations or polypi are present and there is carious bone. A cholesteatoma may exist for years in the antrum without occasioning serious trouble until some inflammatory symptoms arise.

Although during the course of a chronic purulent otitis media there may at stated intervals be attacks of pain in the mastoid process which do not lead to abscess, it is well to bear in mind the fact that serious complications are liable to develop at any moment, such as sinus thrombosis, meningitis, brain abscess, suppurative labyrinthitis, perforation of the mastoid tip, septicæmia, pyæmia, etc., unless operative measures are undertaken at an early period. In tubercular cases there may be great destruction of bone without any well-marked symptoms of pain. In such cases formerly it was considered inadvisable to operate. Experience, however, goes to show that removal of carious bone and tubercular material is followed often by marked improvement in the patient's general health, and such an operation should always be undertaken, provided the patient's general condition is satisfactory. As hygienic surroundings as well as good food are so necessary in the care of these unfortunate patients, it is to be hoped that in the near future wards will be so constructed on the roofs of all hospitals that the fresh-air treatment can be successfully carried out in all cases of tuberculosis. Much has already been accomplished on these lines.

If left to nature, perforation of the external bony wall of the mastoid takes place in some cases, an abscess forming in the soft tissues, which ruptures and leaves one or more sinuses leading to carious bone. The external cortex is the most frequent seat of perforation, although the pus may force a passage through in other directions.

In Fig. 122 a sequestrum, three-quarters of an inch by three-quarters of an inch in size, is shown, which was removed by operation. It consists of the greater part of the external wall of the mastoid of a boy, aged two years, who had had a recent attack of measles. The right ear had been discharging for a month, and an abscess had ruptured behind the ear, which gave great relief to the pain.

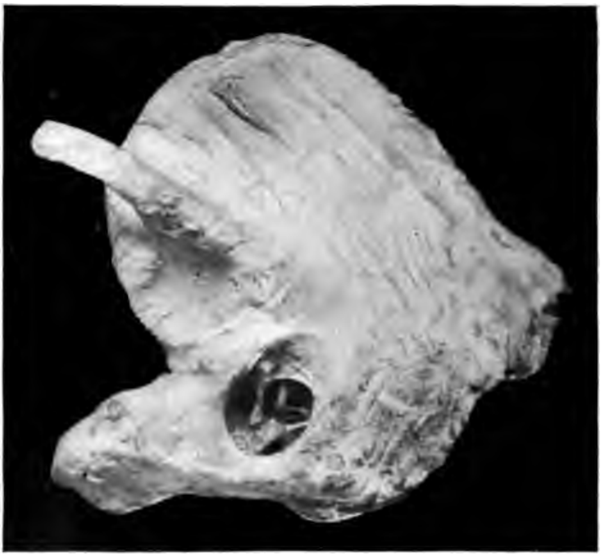
Diagnosis. The diagnosis can be made if there is pain on pressure over some portion of the mastoid, with constriction of the external meatus, retention of pus, and granulations present in the canal. In cases of cholesteatoma it is more difficult to decide, because frequently the pain is slight; while, on the other hand, in osteosclerosis the pain is often quite severe.

Prognosis. A guarded prognosis should always be given when the patient is debilitated, tuberculous, or cachectic, or there are extensive caries and necrosis of the temporal bone or some intracranial complication.

Treatment. Whenever symptoms of mastoid disease are well marked in a case of chronic purulent otitis media, the first object of the surgeon should be to establish good drainage from the middle ear. All granulations or polypi should be removed carefully from the canal, so that one can see the drumhead or what remains of it. At times, especially when the pain in the mastoid is due to inflammation, and not to the retention of pus or cholesteatomatous masses, antiphlogistic measures will be sufficient; but, as a rule, it is much more advisable to open the mastoid antrum, for with only slight symptoms a patient may develop some intracranial complication, and it is not prudent to wait long before operating.

If only a rim of the drumhead remains (see Fig. 162), while the ossicles are carious and the disease seems to be limited mostly to the attic, it is undoubtedly true that in some instances a cure can be established by excision of the drumhead and ossicles, and by curetting and washing out the attic and tympanic cavity with antiseptic solutions through a middle-ear canula. The same holds true of cases in which the perforation is in Shrapnell's membrane and pus is pent up in the attic.

FIG. 162.



Drumhead almost entirely destroyed. Rim of membrane left in the upper portion. Ossicles bound down by adhesions. Long handle of malleus attached to inner wall of middle ear.

When the attic contains cholesteatomatous masses it is always advisable to open the antrum, for the surgeon can never be certain of the extent of the disease until he has explored the mastoid cells. On perforating the outer cortex of the mastoid he may find complete destruction of the entire mastoid cells.

The surgeon should always operate whenever there are sinuses in the mastoid region leading to carious bone, or when the posterior bony wall of the meatus is diseased.

In certain cases in which the mastoid becomes eburnated and the cells have disappeared, great relief will follow the chiselling away of portions of the mastoid process, and especially is it important to make an opening through to the antrum.

In chronic mastoid inflammation it is always advisable to enter the antrum, in order to enable the surgeon to wash it out, together with the middle ear, through the opening behind the auricle. In a pneumatic or diploëtic mastoid process one should investigate the entire bone, from the antrum to the tip, being careful not to injure the sigmoid sinus, which occasionally runs very close to the antrum in a sclerosed or diploëtic mastoid process. If the operation is done carefully under aseptic conditions, and the patient's general health is fairly satisfactory, the operation is generally successful. In cases of diabetes, when the disease is in an advanced stage, the operation is one of more or less gravity, but should be undertaken when the patient's life is in danger from extension of the inflammation to the brain. If acetone is present in the urine, a very guarded prognosis as to recovery should be given, as the complication is a serious one.

The same instruments are used as in the operation for acute mastoid disease, and the same solutions.

The incision is identical with the one recommended previously, and the entire mastoid process should be inspected.

In cases of *osteosclerosis* it is generally advisable to chisel away sufficient bone to reach the antrum and establish drainage with the middle ear. Such a procedure usually relieves the pain, which is so distressing to the patient.

One should, of course, be careful not to injure the sigmoid sinus, which may be exposed and covered with granulations, or the facial nerve, or the dura itself.

Instead of the disease being limited to the mastoid process, the surgeon may find that the posterior bony wall of the meatus or the walls of the tympanum are carious. With the object of removing the outer wall of the attic and the posterior superior bony wall of the meatus, surgeons have devised different methods of operation, the idea being to expose entirely the tympanic cavity and remove all carious bone. This procedure, viz., removal of the posterior superior bony wall and outer wall of the attic, is indicated in cases in which there is extensive caries involving the attic and antrum, the middle ear, or bony meatus, and especially where there are cholesteatomatous masses or numerous granulations or polypi which impede the drainage from the tympanic cavity.

STACKE OPERATION. Stacke divides the operation into three steps:

1. Incision through the soft tissues.
2. Removal of the cortex of the suprameatal triangle and the posterior bony canal, and the extraction of carious ossicles, with curetting of the tympanum, aditus, and antrum.

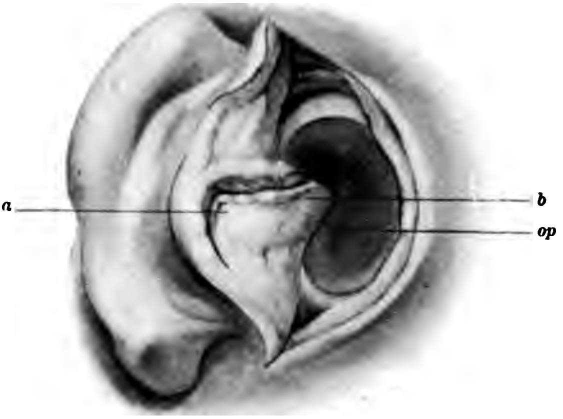
3. Construction of the flap from the membranous canal and its application to the walls of the bony canal, antrum, etc.

The various steps in the operation are performed as follows: An incision is made through the soft tissues, following closely the attachment of the auricle, and extending from one centimetre (three-eighths of an inch) below the mastoid tip upward to a point a little above and forward of the superior border of the external auditory meatus; the lower two-thirds of the incision is made directly down to the bone through the periosteum; the upper third extends through the skin only down to the fascia of the temporal muscle. This muscle and fascia are then drawn aside and an incision made through the periosteum underlying them and bordering upon the superior margin of the bony meatus. The periosteum of the anterior flap is then elevated and drawn forward until the suprameatal triangle and posterior wall of the bony canal are plainly exposed, this procedure being simplified at times by cutting away a few fibres of the sterno-cleido-mastoid muscle at the tip, so as to afford greater room. This stage of the operation is completed by separating the membranous canal from its bony attachments and by pulling it outward. A retractor is then introduced and the soft parts are pulled forward, so that the bony structures, including the tympanic ring, are seen readily.

The second step consists in cutting the tensor tympani muscle and extracting the malleus, if it is visible, through the canal; then the remnant of the drum membrane, if any is left, is excised and Stacke's protector is introduced into the attic. The bone forming the external wall of the attic is cut away and the incus removed. The protector is then inserted into the aditus ad antrum and the bony wall external to it chiselled away so that the protector can be pushed into the antrum.

The overlying cortex and remainder of the posterior bony wall are removed with a chisel. The protector acts as a guard to insure the safety of the facial nerve. By such means the antrum, attic, aditus and tympanum are converted into one large continuous space, which must be curetted thoroughly for the removal of granulations and all soft carious spots in the contiguous walls.

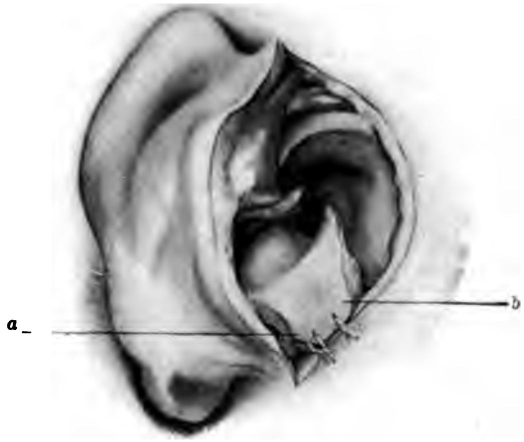
Fig. 163.



Flap incision in Stacke operation. (Gerber). *a* and *b* flaps made from the cartilaginous canal. *op*. bone cavity the result of operation.

The third step in the operation consists in making a horizontal incision in the vertical meridian of the membranous canal above and extending from the tympanic ring, the entire length of the canal, outward to the concha. A second incision is now made, beginning in the concha, where the first one terminates, and running at right angles to it downward and backward in the canal, thus making a nearly four-cornered flap (Fig. 163), which is crowded backward and downward by tampons which are inserted through the external auditory canal, so as to cover as much as possible of the denuded bone. Antrum, aditus and tympanum are now packed with gauze, without irrigation, and the skin of the upper half of the flap closed with sutures, the lower half being covered with antiseptic gauze and bandaged. In cases in which the post-auricular opening is not closed immediately Stacke stitches the upper edge of the flap to the inferior angle of the wound. (Fig. 164).

FIG. 164.



Stacke's flap in position. (Gerber) *a* and *b* flaps.

The object of the subsequent treatment is to secure, if possible, a smooth epidermal covering of the large cavity made in the bone. Granulations form upon the raw surface of the bone, and when they become exuberant should be cauterized with nitrate of silver or the galvano-cautery. The epidermis should advance from the sides and cover the entire surface.

Stacke keeps the patient in bed for seven or eight days. The outer dressing may be removed earlier, but the deeper dressings are not changed until the eighth day. The dressings after this are changed more frequently, and finally are dispensed with when it is apparent to the surgeon that the epidermis has covered more or less of the excavation.

SCHWARTZE-STACKE OPERATION. Schwartze's operation differs in several important points from the method advocated by Stacke. In the first place, Schwartze does not believe in separating the entire membranous canal from its bony attachments and in pulling it out, provided the calibre of the canal is not abnormally narrow. He leaves the anterior wall attached to the bone, in order to prevent subsequent necrosis and the formation of a sequestrum in the external meatus. He introduces a slender retractor and pulls the soft parts forward, thus gaining a sufficient amount of space. Then he opens the mastoid antrum, starting from the outer surface of the mastoid process in the usual way, and proceeds from this point to complete the operation, instead of cutting the bone from within outward, as Stacke suggests, viz., by beginning the operation in the attic, and then passing a protector upward and backward into the antrum as a guide for entering the latter cavity.

Schwartze does not believe in the use of the Stacke protector, for the reason that it is likely to injure the tegmen tympani. He recommends, on the other hand, a broad chisel, and considers that with short and careful blows of the hammer there is little danger of injuring the stapes, which usually lies embedded and protected in the swollen mucous membrane. He advises the use of a sublimate solution (1 : 1000), not only during the operation, but later in the changing of the dressings whenever there is any noticeable fetor. He also recommends the syringing of a sterilized salt solution through the Eustachian catheter into the middle ear in cases in which there is caries about the tympanic opening of the Eustachian tube. If there is no fetor, however, he does not irrigate the wound, but simply dusts over it iodoform powder. He does not close the mastoid wound at all immediately after the operation, believing that the packing with gauze cannot be accomplished successfully through the external auditory canal alone. Schwartze does not change the first dressings till the sixth day, unless the patient has fever, or a discharge from the wound, or else complains of pain. If, on the other hand, the surgeon has decided to close the mastoid wound immediately after the operation, he should not allow the dressings to remain unchanged longer than three days, for fear that the retained secretion may force open the sutures. As iodoform gauze tends to irritate the tissues and to favor the growth of exuberant granulations, it should be used only in the first dressings. Otherwise he prefers simple sterilized gauze, and when the epidermis begins to form he advocates the use of aristol powder, to protect the newly formed skin. He discontinues the tampons and allows the mastoid wound to close through cicatricial contraction, when the epidermis has already extended over the greater portion of the antrum, aditus ad antrum, and middle ear.

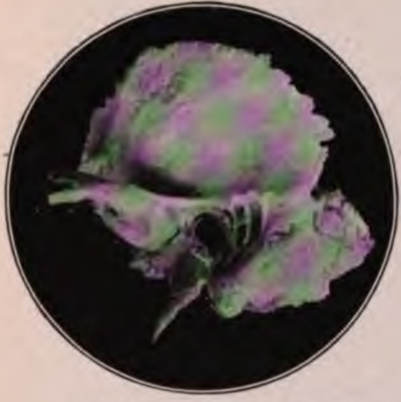
In order to prevent the occurrence of stenosis from the growing together of exuberant granulations, the latter should be destroyed with a knife especially constructed for the purpose or by means of the galvano-cautery. Great care should be taken to keep the aditus ad antrum open in order to secure good drainage.

Schwartze believes that the employment of the lead-nail is preferable to packing the wound with gauze in many cases, because the latter method is extremely painful, and since the treatment must be kept up for weeks, this is an important consideration, especially in the case of children. On account of the severe pain experienced in changing the dressings it is often advisable to moisten the tissues with a 20 per cent. solution of cocaine.

Various modifications of these different operations have been suggested and practised by different surgeons.

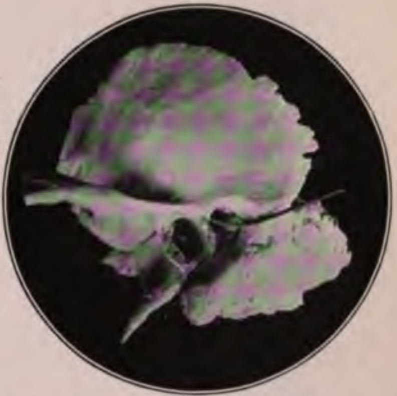
[illegible]'s Method. First, cut down on the mastoid process and lay bare the antrum, and remove all carious and softened bone in the mastoid process. Second, remove with chisels and rongeur forceps the posterior bony canal wall in its superior quadrant, care being taken not to injure the facial nerve. Besides scraping away all granulations and diseased bone in the antrum and mastoid cells, the ossicles should be extracted and the attic gently curetted. Great care should be taken not to injure the facial nerve when curetting, and one should never scrape the inner wall of the middle ear for fear of carrying the infection to the labyrinth. Meningitis and death have resulted from this procedure in several instances (see Figs. 104, 105).

FIG. 165.



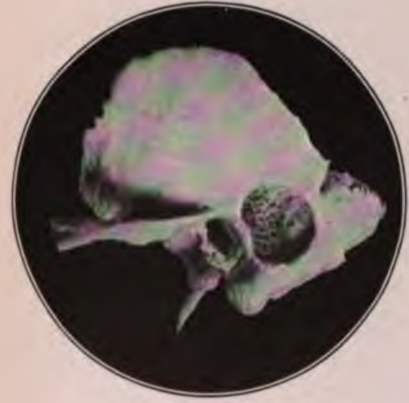
First step in the operation, viz., opening the antrum.

FIG. 166.



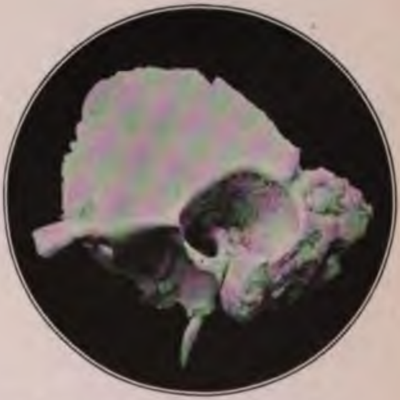
Antrum exposed with probe passed into middle ear.

FIG. 167.



Mastoid cells removed.

FIG. 168.



Posterior bony canal wall removed and antrum, attic, tympanun, and mastoid cells converted into one cavity.

SCHWARTZE-STACKE OPERATION.

In all cases in which the disease is limited to the attic and antrum, and there is no evidence of cholesteatoma nor exposure of the dura, and especially when the lower two-thirds of the mastoid process is sclerosed, the posterior opening should be closed and the wound treated through the external auditory canal. Before doing this, however, flaps are formed by making a horizontal incision in the vertical meridian of the membranous canal above, and extending from the tympanic ring the entire length outward to the concha (third step in Stacke operation, p. 395). The flaps thus formed are pushed against the inner walls of the cavity by strips of sterile or mild iodoform gauze introduced through the external auditory meatus. If, on the other hand, the case is one of cholesteatoma, or the dura is exposed in either the middle or posterior cranial fossa, a flap is first made (Fig. 163) and then stitched in position (Fig. 164). The wound behind the auricle should be kept partially open, and the cavity allowed to granulate up from the bottom by packing introduced from behind and also through the external auditory canal.

When the packing is first removed it is advisable in some cases to administer nitrous oxide gas in adults, or chloroform in children, as the procedure is a painful one. The subsequent dressings cause but little pain, particularly if balsam of Peru is used to stimulate the granulations. Iodoform gauze is often useful as packing in the canal when the granulations are pale and flabby. When the granulations are exuberant they should be cauterized with nitrate of silver. The scarlet red salve is useful in promoting the healing.

In the writer's experience it is always necessary to curette thoroughly the tympanic orifice of the Eustachian tube, in order to close completely this opening and thus prevent reinfection of the middle ear from the nasopharynx. A strong solution of nitrate of silver is sometimes used to close the orifice of the tube. Thiersch grafts can be used to advantage in some cases after granulations have formed, but primary skin grafts should never be used, nor, as is the practice of some otologists, should they be placed over the dura, as fatal cases have been reported where this has been done. At a meeting of the Otological Section of the New York Academy of Medicine, Gruening reported a fatal case where a most thorough plastic operation had been performed in connection with the radical operation for chronic purulent otitis media. The canal and also the tympanic wall were lined with skin, but behind that skin pus was found and the patient died of meningitis. He called attention to the danger of making large flaps to cover over denuded bone. The author knows of several cases where meningitis and death has resulted from using primary skin grafts, and it is for this reason that he is strongly opposed to them.

CHAPTER XII.

INTRACRANIAL COMPLICATIONS.

BRAIN ABSCESS. THROMBOSIS OF THE SIGMOID AND OTHER SINUSES. LEPTOMENINGITIS.

As a result of chronic purulent otitis media and mastoid inflammation, and, occasionally, of acute purulent otitis media, the thin roof of the tympanum or antrum is liable to be perforated through osseous erosion, and in consequence there follows either a collection of pus in the middle cranial fossa between the bone and the dura—an extradural abscess—or else an abscess forms in the temporo-sphenoidal lobe. Instead of the term extradural abscess some authors designate this condition as external pachymeningitis. When erosion takes place in the bony wall of the mastoid process, which lies over the sigmoid sinus, a collection of pus usually forms about the sinus, and the latter becomes surrounded with granulation tissue (extradural abscess); or a thrombus forms in the sigmoid sinus itself, or else an abscess is developed in the cerebellum.

Before erosion takes place the tympanic roof or inner wall of the mastoid process becomes very thin and of a dark color. The minute veins are often thrombosed, and, owing to the ulceration of the bone, granulations are thrown out from the external surface of the dura or from the wall of the sigmoid sinus, as the case may be, which is nature's method of resisting the further advance of the disease. Absorption of the carious bone takes place at the same time. One should be very careful, therefore, in the removal of polypi from the tympanic cavity, especially when the disease has existed for a long time, for fear of wounding the dura, which rests on the tympanic roof. In the same way, the sigmoid sinus may easily be injured in scraping away softened bone and granulations in operations on the mastoid process. After removing granulation-tissue from the dura mater one is apt to find the latter considerably thickened (see Fig. 171). Granulation-cells and a plastic material are often found, which project upward into the brain substance and become adherent to the pia mater, so that the veins and lymphatics of the pia are liable to be affected. Very small thrombi are undoubtedly carried by the smaller branches of the cerebral arteries which supply the temporal lobe, and in this way give rise to cerebral abscess. The morbid products may also reach the brain tissue by means of the perivascular sheaths. Occasionally it is impossible to find any aperture in the bone, although the latter may be very much discolored.

Cases have been reported, especially in children, in which infective processes have reached the dura from the middle ear by means of the petro-squamosal or other sutures, and in such instances the vessels have been thrombosed. In tubercular disease the entire petrous bone may become carious and nothing remain of it except a thin shell, and in consequence of such disease, tubercular meningitis may develop. When erosion of the bone takes place, either through the tympanic roof or through the inner wall of the mastoid, the patient may have a suppurative leptomeningitis, together with an extradural or cerebral abscess. The roof of the tympanum may be eroded at the same time that the sigmoid sinus is involved, and, as a result, there may be an abscess in the temporo-sphenoidal lobe, together with an infective thrombus in the sigmoid sinus. When all these complications are present in one case, there is great difficulty in making a diagnosis. The plate of bone separating the sigmoid sinus from the mastoid cells is extremely thin, so that erosion of the bone is very likely to be observed at this point. The bone first becomes discolored and softened, and then granulations are thrown out. A collection of pus is found either between the sinus and the bone or behind the sinus, in the direction of the occipital bone. The walls of the sinus become thickened and a thrombus forms, the presence of which may not give rise to immediate mischief; while, on the other hand, in an incredibly short space of time the patient may have most serious and alarming symptoms of sinus thrombosis. If left to nature, the wall of the sinus may become softened, so that a minute perforation takes place. Hemorrhage does not follow, because generally the vessel is occluded both above and below the aperture. By means of the cerebellar veins the infection extends to the cerebellum, or emboli may be carried to the cerebellum through the smaller cerebellar arteries and their perivascular sheaths. As a rule, however, there is direct contact between the sigmoid sinus and the cerebellar abscess, and the infective processes extend from the dura in the same manner as in the case of an abscess in the temporo-sphenoidal lobe. In rare instances the pathogenic processes reach the cerebellum from the tympanic cavity through the internal auditory meatus along the sheath of the auditory or facial nerve. Beside an extradural abscess, or an abscess in the temporo-sphenoidal lobe or cerebellum, an abscess may form between the dura and pia mater which may become circumscribed through adhesions; in consequence of which there may be inflammation and possibly ulceration of the brain-tissue, with softening. The pus may escape through a perforation in the membranes of the brain to the outer surface of the dura or through the roof of the tympanum.

When an abscess has formed in the temporo-sphenoidal lobe, there will frequently be found an opening at the base of the brain which communicates with it, so that abscesses occurring in this portion of the brain are caused generally by direct extension from the seat of the disease—a point to be remembered, for in operating the surgeon should always try to reach the seat of the infective process.

CEREBRAL ABSCESS.

Under this heading should be included (1) extradural abscess, (2) intradural or cerebral abscess—(*a*) *cerebral*, and (*b*) *cerebellar*.

Extradural Abscess.

As already mentioned, the pus in an extradural abscess may be found between the dura mater and tympanic roof or about the sigmoid sinus after the infective process has extended from the mastoid cells. Frequently, when operating for mastoid inflammation, the surgeon finds a carious opening just over the sinus, even when the symptoms indicated only mastoid disease.

A boy, ten years of age, who came to my clinic, had a careworn expression, cold hands, a rapid and bounding pulse, and a temperature of 103° F. He had no distinct chill, but on the preceding day had had chilly sensations. He gave a history of an occasional discharge from both ears for several years, and during the preceding three days had had severe pain in the left mastoid process. He heard the watch only by contact. There was a distinct swelling over the left mastoid, with a point of fluctuation just over the antrum. The mastoid cells were opened, and pus and softened bone were removed from the entire process. The sigmoid sinus was not involved. A probe was introduced into the middle cranial fossa through a carious opening in the tympanic roof. The incision was carried upward, and the bone cut away with rongeur forceps and chisels, so as to expose the dura and evacuate the pus. While the temperature was high in this case, it does not follow that this is the rule, for frequently there is little if any fever. A short time ago a patient came under my care who had a temperature but slightly above normal. He had had a chronic purulent otitis media of some years' duration. He consulted me on account of a sudden pain in the mastoid on the same side. He also had slight facial paralysis. An immediate operation was performed, and not only were the mastoid cells found filled with softened bone and pus, but there was also a large carious opening through the tympanic roof. This opening was enlarged and the pus evacuated. Recovery followed. It should not be forgotten that a leptomeningitis or phlebitis of the sigmoid sinus may complicate a case of extradural abscess.

Symptoms. There are no distinct symptoms by which the surgeon can make a diagnosis of extradural abscess before operation, for, as previously mentioned, osseous erosion in the tympanic roof or in the thin plate of bone covering the sigmoid sinus frequently is discovered only at the time of opening the cells. One should remember that such an accident is especially liable to occur when streptococci are present in the discharge or the patient has tuberculosis or one of the exanthematous diseases. Most cases of extradural abscess occur in connection with chronic purulent otitis media. It may be stated, however, that cases often have been observed in which erosion had taken place during an attack of acute otitis media. One may suspect the existence of an extradural or subdural abscess when the discharge suddenly becomes less or ceases altogether, and the patient shows signs of meningeal irritation. A fatal result may follow from basilar meningitis or abscess of the brain.

Treatment.—An incision behind the auricle should be made as in the operation for mastoid disease and a complete mastoid operation performed. If an opening has occurred in the tegmen tympani or tegmen antri, the incision in the soft tissues should be carried upward and curved forward around the upper border of the auricle (from point 2 to point 4, and from point 2 to point 5, Fig. 147), thus displacing the latter forward, so that the surgeon will be enabled to cut away the bone with forceps and chisels, and thus have an opportunity of exploring the middle cranial fossa and of removing all carious bone. A narrow strip of iodoform gauze should be inserted through this opening and the wound allowed to fill up with granulation-tissue. The mastoid cavity should be treated in the manner already described (see chapter on Mastoid Diseases). The surgeon should never inject any solution into the cranial

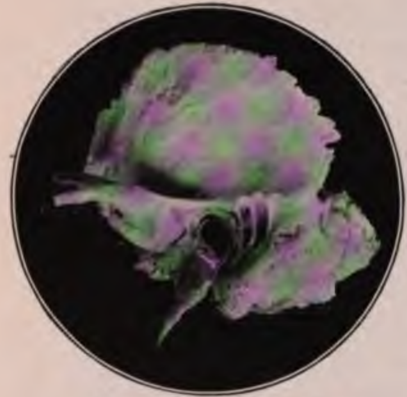
In order to prevent the occurrence of stenosis from the growing together of exuberant granulations, the latter should be destroyed with a knife especially constructed for the purpose or by means of the galvano-cautery. Great care should be taken to keep the aditus ad antrum open in order to secure good drainage.

Schwartze believes that the employment of the lead-nail is preferable to packing the wound with gauze in many cases, because the latter method is extremely painful; and since the treatment must be kept up for weeks, this is an important consideration, especially in the case of children. On account of the severe pain experienced in changing the dressings it is often advisable to moisten the tissues with a 20 per cent. solution of cocaine.

Various modifications of these different operations have been suggested and practised by different surgeons.

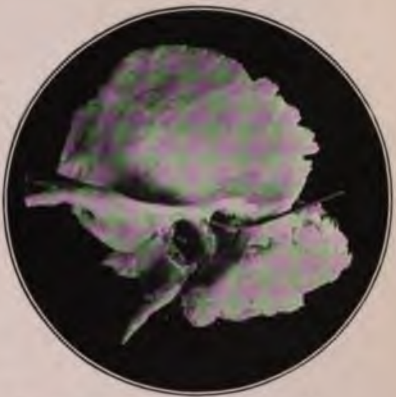
Author's Method. First, cut down on the mastoid process and lay bare the antrum, and remove all carious and softened bone in the mastoid process. Second, remove with chisels and rongeur forceps the posterior bony canal wall in its superior quadrant, care being taken not to injure the facial nerve. Besides scraping away all granulations and diseased bone in the antrum and mastoid cells, the ossicles should be excised and the attic gently curetted. Great care should be taken not to injure the facial nerve when curetting, and one should never scrape the inner wall of the middle ear for fear of carrying the infection to the labyrinth. Meningitis and death have resulted from this procedure in several instances (see Figs. 165–168).

Fig. 165.



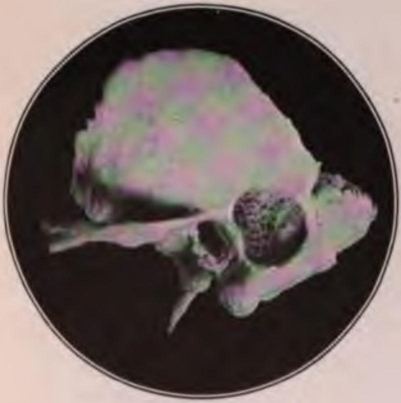
First step in the operation, viz., opening the antrum.

Fig. 166.



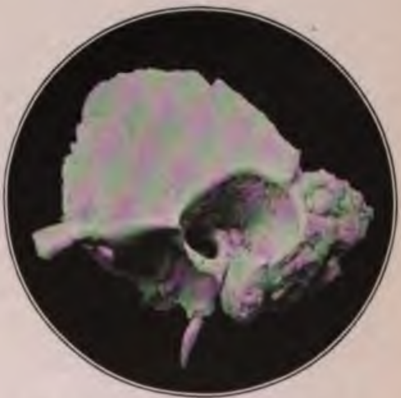
Antrum exposed with probe passed into middle ear.

Fig. 167.



Mastoid cells removed.

Fig. 168.



Posterior bony canal wall removed and antrum, attic, tympanun, and mastoid cells converted into one cavity.

Schwartze-Stacke Operation.

In all cases in which the disease is limited to the attic and antrum, and there is no evidence of cholesteatoma nor exposure of the dura, and especially when the lower two-thirds of the mastoid process is sclerosed, the posterior opening should be closed and the wound treated through the external auditory canal. Before doing this, however, flaps are formed by making a horizontal incision in the vertical meridian of the membranous canal above, and extending from the tympanic ring the entire length outward to the concha (third step in Stacke operation, p. 395). The flaps thus formed are pushed against the inner walls of the cavity by strips of sterile or mild iodoform gauze introduced through the external auditory meatus. If, on the other hand, the case is one of cholesteatoma, or the dura is exposed in either the middle or posterior cranial fossa, a flap is first made (Fig. 163) and then stitched in position (Fig. 164). The wound behind the auricle should be kept partially open, and the cavity allowed to granulate up from the bottom by packing introduced from behind and also through the external auditory canal.

When the packing is first removed it is advisable in some cases to administer nitrous oxide gas in adults, or chloroform in children, as the procedure is a painful one. The subsequent dressings cause but little pain, particularly if balsam of Peru is used to stimulate the granulations. Iodoform gauze is often useful as packing in the canal when the granulations are pale and flabby. When the granulations are exuberant they should be cauterized with nitrate of silver. The scarlet red salve is useful in promoting the healing.

In the writer's experience it is always necessary to curette thoroughly the tympanic orifice of the Eustachian tube, in order to close completely this opening and thus prevent reinfection of the middle ear from the nasopharynx. A strong solution of nitrate of silver is sometimes used to close the orifice of the tube. Thiersch grafts can be used to advantage in some cases after granulations have formed, but primary skin grafts should never be used, nor, as is the practice of some otologists, should they be placed over the dura, as fatal cases have been reported where this has been done. At a meeting of the Otological Section of the New York Academy of Medicine, Gruening reported a fatal case where a most thorough plastic operation had been performed in connection with the radical operation for chronic purulent otitis media. The canal and also the tympanic wall were lined with skin, but behind that skin pus was found and the patient died of meningitis. He called attention to the danger of making large flaps to cover over denuded bone. The author knows of several cases where meningitis and death has resulted from using primary skin grafts, and it is for this reason that he is strongly opposed to them.

CHAPTER XII.

INTRACRANIAL COMPLICATIONS.

BRAIN ABSCESS. THROMBOSIS OF THE SIGMOID AND OTHER SINUSES. LEPTOMENINGITIS.

As a result of chronic purulent otitis media and mastoid inflammation, and, occasionally, of acute purulent otitis media, the thin roof of the tympanum or antrum is liable to be perforated through osseous erosion, and in consequence there follows either a collection of pus in the middle cranial fossa between the bone and the dura—an extradural abscess—or else an abscess forms in the temporo-sphenoidal lobe. Instead of the term extradural abscess some authors designate this condition as external pachymeningitis. When erosion takes place in the bony wall of the mastoid process, which lies over the sigmoid sinus, a collection of pus usually forms about the sinus, and the latter becomes surrounded with granulation tissue (extradural abscess); or a thrombus forms in the sigmoid sinus itself, or else an abscess is developed in the cerebellum.

Before erosion takes place the tympanic roof or inner wall of the mastoid process becomes very thin and of a dark color. The minute veins are often thrombosed, and, owing to the ulceration of the bone, granulations are thrown out from the external surface of the dura or from the wall of the sigmoid sinus, as the case may be, which is nature's method of resisting the further advance of the disease. Absorption of the carious bone takes place at the same time. One should be very careful, therefore, in the removal of polypi from the tympanic cavity, especially when the disease has existed for a long time, for fear of wounding the dura, which rests on the tympanic roof. In the same way, the sigmoid sinus may easily be injured in scraping away softened bone and granulations in operations on the mastoid process. After removing granulation-tissue from the dura mater one is apt to find the latter considerably thickened (see Fig. 171). Granulation-cells and a plastic material are often found, which project upward into the brain substance and become adherent to the pia mater, so that the veins and lymphatics of the pia are liable to be affected. Very small thrombi are undoubtedly carried by the smaller branches of the cerebral arteries which supply the temporal lobe, and in this way give rise to cerebral abscess. The morbid products may also reach the brain tissue by means of the perivascular sheaths. Occasionally it is impossible to find any aperture in the bone, although the latter may be very much discolored.

Cases have been reported, especially in children, in which infective processes have reached the dura from the middle ear by means of the petro-squamosal or other sutures, and in such instances the vessels have been thrombosed. In tubercular disease the entire petrous bone may become carious and nothing remain of it except a thin shell, and in consequence of such disease, tubercular meningitis may develop. When erosion of the bone takes place, either through the tympanic roof or through the inner wall of the mastoid, the patient may have a suppurative leptomeningitis, together with an extradural or cerebral abscess. The roof of the tympanum may be eroded at the same time that the sigmoid sinus is involved, and, as a result, there may be an abscess in the temporo-sphenoidal lobe, together with an infective thrombus in the sigmoid sinus. When all these complications are present in one case, there is great difficulty in making a diagnosis. The plate of bone separating the sigmoid sinus from the mastoid cells is extremely thin, so that erosion of the bone is very likely to be observed at this point. The bone first becomes discolored and softened, and then granulations are thrown out. A collection of pus is found either between the sinus and the bone or behind the sinus, in the direction of the occipital bone. The walls of the sinus become thickened and a thrombus forms, the presence of which may not give rise to immediate mischief; while, on the other hand, in an incredibly short space of time the patient may have most serious and alarming symptoms of sinus thrombosis. If left to nature, the wall of the sinus may become softened, so that a minute perforation takes place. Hemorrhage does not follow, because generally the vessel is occluded both above and below the aperture. By means of the cerebellar veins the infection extends to the cerebellum, or emboli may be carried to the cerebellum through the smaller cerebellar arteries and their perivascular sheaths. As a rule, however, there is direct contact between the sigmoid sinus and the cerebellar abscess, and the infective processes extend from the dura in the same manner as in the case of an abscess in the temporo-sphenoidal lobe. In rare instances the pathogenic processes reach the cerebellum from the tympanic cavity through the internal auditory meatus along the sheath of the auditory or facial nerve. Beside an extradural abscess, or an abscess in the temporo-sphenoidal lobe or cerebellum, an abscess may form between the dura and pia mater which may become circumscribed through adhesions; in consequence of which there may be inflammation and possibly ulceration of the brain-tissue, with softening. The pus may escape through a perforation in the membranes of the brain to the outer surface of the dura or through the roof of the tympanum.

When an abscess has formed in the temporo-sphenoidal lobe, there will frequently be found an opening at the base of the brain which communicates with it, so that abscesses occurring in this portion of the brain are caused generally by direct extension from the seat of the disease—a point to be remembered, for in operating the surgeon should always try to reach the seat of the infective process.

CEREBRAL ABSCESS.

Under this heading should be included (1) extradural abscess, (2) intradural or cerebral abscess—(*a*) *cerebral,* and (*b*) *cerebellar.*

Extradural Abscess.

As already mentioned, the pus in an extradural abscess may be found between the dura mater and tympanic roof or about the sigmoid sinus after the infective process has extended from the mastoid cells. Frequently, when operating for mastoid inflammation, the surgeon finds a carious opening just over the sinus, even when the symptoms indicated only mastoid disease.

A boy, ten years of age, who came to my clinic, had a careworn expression, cold hands, a rapid and bounding pulse, and a temperature of 103° F. He had no distinct chill, but on the preceding day had had chilly sensations. He gave a history of an occasional discharge from both ears for several years, and during the preceding three days had had severe pain in the left mastoid process. He heard the watch only by contact. There was a distinct swelling over the left mastoid, with a point of fluctuation just over the antrum. The mastoid cells were opened, and pus and softened bone were removed from the entire process. The sigmoid sinus was not involved. A probe was introduced into the middle cranial fossa through a carious opening in the tympanic roof. The incision was carried upward, and the bone cut away with rongeur forceps and chisels, so as to expose the dura and evacuate the pus. While the temperature was high in this case, it does not follow that this is the rule, for frequently there is little if any fever. A short time ago a patient came under my care who had a temperature but slightly above normal. He had had a chronic purulent otitis media of some years' duration. He consulted me on account of a sudden pain in the mastoid on the same side. He also had slight facial paralysis. An immediate operation was performed, and not only were the mastoid cells found filled with softened bone and pus, but there was also a large carious opening through the tympanic roof. This opening was enlarged and the pus evacuated. Recovery followed. It should not be forgotten that a leptomeningitis or phlebitis of the sigmoid sinus may complicate a case of extradural abscess.

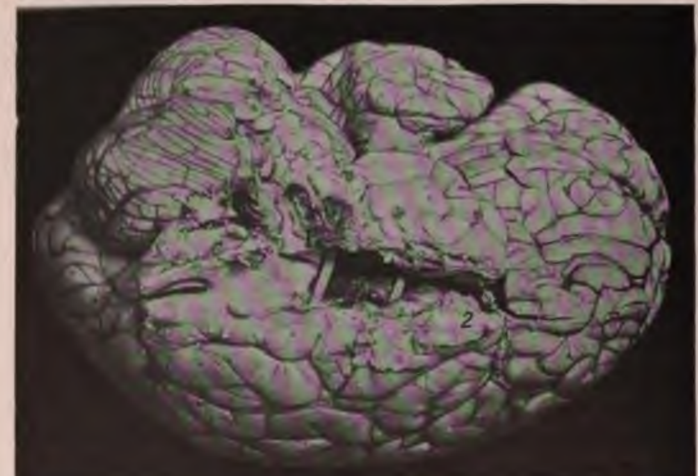
Symptoms. There are no distinct symptoms by which the surgeon can make a diagnosis of extradural abscess before operation, for, as previously mentioned, osseous erosion in the tympanic roof or in the thin plate of bone covering the sigmoid sinus frequently is discovered only at the time of opening the cells. One should remember that such an accident is especially liable to occur when streptococci are present in the discharge or the patient has tuberculosis or one of the exanthematous diseases. Most cases of extradural abscess occur in connection with chronic purulent otitis media. It may be stated, however, that cases often have been observed in which erosion had taken place during an attack of acute otitis media. One may suspect the existence of an extradural or subdural abscess when the discharge suddenly becomes less or ceases altogether, and the patient shows signs of meningeal irritation. A fatal result may follow from basilar meningitis or abscess of the brain.

Treatment.—An incision behind the auricle should be made as in the operation for mastoid disease and a complete mastoid operation performed. If an opening has occurred in the tegmen tympani or tegmen antri, the incision in the soft tissues should be carried upward and curved forward around the upper border of the auricle (from point 2 to point 4, and from point 2 to point 5, Fig. 147), thus displacing the latter forward, so that the surgeon will be enabled to cut away the bone with forceps and chisels, and thus have an opportunity of exploring the middle cranial fossa and of removing all carious bone. A narrow strip of iodoform gauze should be inserted through this opening and the wound allowed to fill up with granulation-tissue. The mastoid cavity should be treated in the manner already described (see chapter on Mastoid Diseases). The surgeon should never inject any solution into the cranial cavity unless he is certain that there is no opening in the dura. The edges of the wound should be washed with a saturated boric acid solution.

INTRADURAL OR CEREBRAL ABSCESS.

Abscesses of the brain occurring as a result of middle-ear inflammation are found usually in either the temporo-sphenoidal lobe or the cerebellum. Cases of extradural abscess are observed much more frequently than abscesses either in the temporo-sphenoidal lobe or cerebellum. Cerebral abscess almost always occurs in connection with chronic purulent otitis media. A case[1] of temporo-sphenoidal abscess has been reported by the au-

FIG. 169.



1. Primary abscess cavity connected with sinus in tympanic roof. 2. Secondary abscess cavity in temporo-sphenoidal lobe. Both abscess cavities found free from pus at autopsy.

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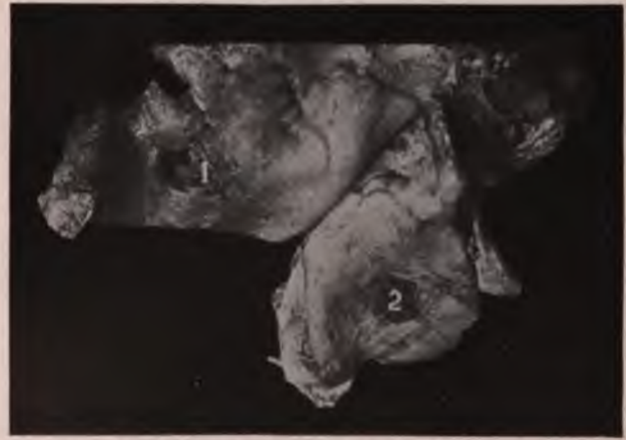
[1] Bacon: Archives of Otology, 1896, vol. xxv, No. 3.

thor which followed acute otitis media (see Fig. 169). In this case the disease was limited mostly to the attic, the acute otitis media being of only eight weeks' duration. Several incisions were made in Shrapnell's membrane, which not only gave exit to a few drops of pus, but afforded at the same time great relief to the patient. He finally consented to enter the hospital and receive proper treatment, but only after serious symptoms had manifested themselves. An operation was performed and an abscess in the temporo-sphenoidal lobe evacuated. He died, however, two hours after the operation, apparently from shock (see Fig. 172). At the post-mortem a carious opening was found in the tympanic roof (see Fig. 170), with thickened dura over it, and a small sinus in the latter leading to a small cerebral abscess cavity, which was empty. Another abscess

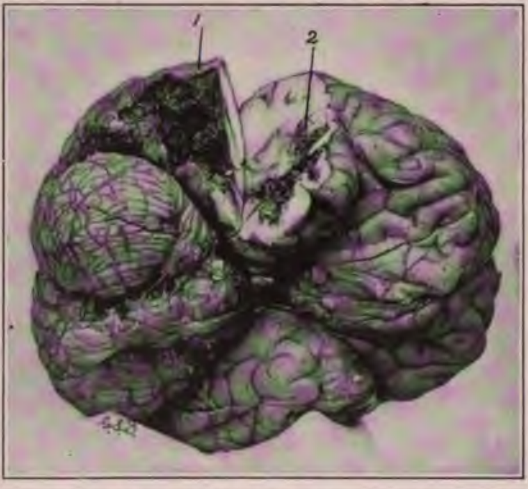
FIG. 170.



1. Carious opening in tympanic roof. 2. Thickened dura turned back, but when in position covers carious opening.

cavity was found at the inner half of the third temporo-sphenoidal convolution (Fig. 169). This cavity was also free from pus, as it had been evacuated at the operation. There was probably some connection between the two abscess cavities, although none could be detected with a probe. In three cases[1] of abscess in the temporo-sphenoidal lobe and one in the cerebellum in which an operation was performed, all were due to chronic purulent otitis media. In some cases the outer surface of the brain may break down and pus may form, due to inflammation of the dura and the pia. In some instances there is simply a circumscribed meningitis without the formation of pus.

FIG. 171.



Photograph of brain showing (1) a portion of hernia cerebri and (2) abscess cavity in temporo-sphenoidal lobe.

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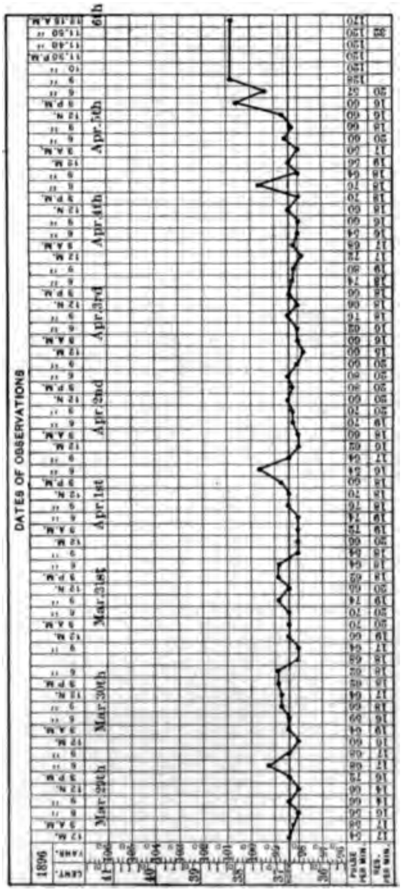
[1] Bacon: New York Eye and Ear Infirmary Reports, January, 1897.

Symptoms. The first stage of abscess is marked usually by irregular symptoms, such as irritability, pain, nausea, or vomiting, and frequently the discharge from the ear becomes scanty or stops altogether. Change in a patient's disposition—viz., a talkative person becoming

FIG. 172



Temperature-chart of a typical case of abscess of the brain without complications, following acute purulent otitis media.

morose, or *vice versa*—is another symptom of importance. The patient frequently complains of chilly sensations. As the disease progresses the cerebration becomes dull and the patient appears stupid and restless. When pus has formed in the brain, the most important symptoms are a distinct lowering of the pulse-rate and a temperature either slightly above normal or subnormal (see Fig. 172). There are exceptions to this rule, for in a case[1] of temporo-sphenoidal abscess reported by me the pulse was rapid and the temperature very high with marked fluctuations, so that thrombosis of the lateral sinus was suspected (see Fig. 173). The patient was a man, thirty-two years of age, who had had a chronic otorrhœa on the left side for at least fifteen years, as a result of measles. He received no treatment to speak of during this time, until his family physician was suddenly sent for. The patient had at that time a temperature of 104° F., an intense headache, and marked pain in the ear. Later he had a severe convulsion lasting twenty minutes, with violent muscular twitching and frothing at the mouth. He also had chills. The symptoms were characteristic of sinus thrombosis. At the operation, however, the sinus was found normal, but there was a large abscess in the temporo-sphenoidal lobe;[2]

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[1] New York Medical Journal, August, 1896.

[2] January 1, 1909. This patient has had 23 convulsions of an epileptic type at various times from December, 1895, to April, 1906, the first one having occurred before the operation for brain abscess. In April, 1906, he had two within an interval of one week between the attacks. Before that he had been free from them for two years. The last two attacks came on after severe mental work, and before the last one he had a premonition lasting about eight to ten minutes. He was using a typewriter, and his mind suddenly became confused. He got up and put it away. The convulsions last generally about fifteen to twenty minutes, although during the early seizures the duration was longer. At first there is a start or groan, then a stiffening of the whole body, followed by a twitching of the muscles of the face, then of the arms and the rest

the patient recovered. This case proves that, exceptionally, a patient with a cerebral abscess may have chills and a high temperature, as well as convulsions, so that a differential diagnosis between abscess of the brain aud sinus thrombosis becomes extremely difficult.

When aphasia develops in a patient with a chronic purulent otitis media of the left side, it is fairly certain, if the patient is right-handed, that there is a collection of pus in the temporo-sphenoidal lobe. This symptom is of the highest diagnostic value—*optical aphasia*, so called and described by different writers. The patient when shown an object knows it, but is unable to name it; but he is able to recognize and understand its name, and will often describe the object. He can sometimes name the object if allowed to handle or smell it. In the case referred to, where the temperature was high, the patient had well-marked aphasic symptoms. Beside the difficulty in naming an object, he could not readily call to mind the appearance of the object. Starr has called this symptom *visual amnesia*, and says "it is due to a suspension of function of an association

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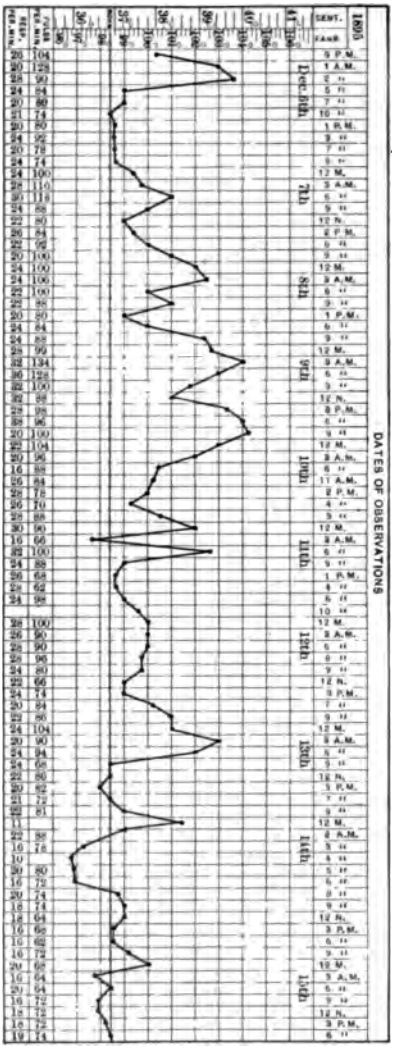
of the body. There is also some frothing at the mouth. His wife says that, in the premonitory stage, the pupils contract to the size of a pin's head; then the muscles of the mouth begin to twitch before he becomes rigid. Most of the attacks have occurred after retiring. At the last time he did not lose consciousness. The pupils contracted, and he had a chill, followed by fever. He has had a chill, followed by fever, after each convulsion. The pulse, after each seizure, would become very weak. He has been free from convulsions since April, 1906. At first there was hardly any premonition. He has not taken any alcohol for the past five years. He has been in the habit of taking bromides when he has felt tired. Except for these attacks he has been in fairly good health, and he has been able to do an unusual amount of literary work.

January 5, 1913. This patient had a slight convulsion a few days ago, followed by an attack of acute mania, when he tried to jump out of a window. The attack lasted but half an hour, and until this convulsion occurred he had been free from them for six years.

FIG. 173.

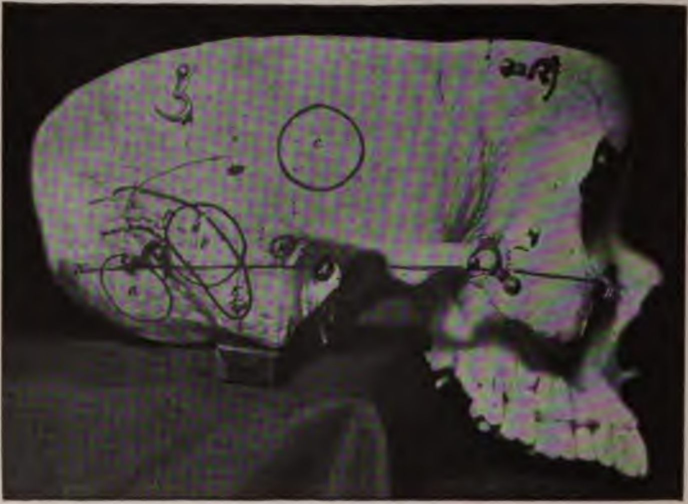


Temperature-chart of an uncomplicated case of abscess in the temporo-sphenoidal lobe, as a result of chronic suppurative otitis media. Course of the temperature very unusual, suggestive of sinus thrombosis.

tract lying in the temporo-occipital lobes and occupying the white matter deep under the cortex. It lies in a position in which it is almost inevitably affected by abscess of the temporal lobe developing after otitis media. In left-handed persons it will occur in abscess of the right side." Severe headache is also an important symptom. Inflammation of the optic nerve may or may not be present. It is observed more frequently in cases of cerebellar than of temporo-sphenoidal abscess. According to the statistics of the Halle Clinic as given by Hansen, optic neuritis in cerebral abscess was bilateral in 87.50 per cent. of the cases while the eye of the affected side alone was involved in 12.5 per cent. The mastoid cells often are found dense and like ivory in cases of cerebral abscess. This seems to me an important point, for in such instances the pus is likely to perforate the tympanic roof, and thus cause an extradural abscess or an abscess in the temporo-sphenoidal lobe. Percussion of the skull on the affected side frequently causes pain, and Macewen has called attention to the fact that there is a difference in the percussion note on the side of the head in which the abscess is located. Other symptoms sometimes noticed are digestive disturbances, increase of reflexes in the limbs of the side opposite to the abscess, a difference in the size of the pupils, and facial paralysis.

In *cerebellar abscess* the most characteristic symptoms, beside slow pulse and low temperature, are severe headache, nausea, vomiting, vertigo, a staggering gait, and facial paralysis. Facial paralysis may be due to pressure on the nerve in the pons. It should be remembered that the nerve may be affected in its course through the middle ear. I have seen a case in which the pulse was slow and the patient had vertigo, vomiting, deafness, severe headache, etc., so that a diagnosis of cerebellar abscess was made. When the antrum was opened, the semicircular canals were carious, which fact accounted for the symptoms. It is very important to examine thoroughly the external auditory canals in all cases of suspected cerebral abscess; for instance, in the case of a child who was brought to my clinic a short time

Fig. 174.



A. External auditory meatus. *B B′*. Reid's base-line running from lower margin of the orbit through the centre of the external auditory meatus. *C*. Trephine opening, ¾ inch in diameter, to expose temporo-sphenoidal abscess, centre-pin of trephine being placed 1¼ inches above the centre of the external bony meatus. *D*. Point at which the mastoid antrum should be opened. *E E′*. Position of sigmoid sinus. *F*. Trephine opening, ¾ inch in diameter, for exposing sigmoid sinus, centre-pin of trephine being placed at a point 1 inch behind and ¼ inch above centre of external bony meatus. *G*. Trephine opening for cerebellar abscess, centre-pin being placed 2 inches behind and ¼ inch below centre of external bony meatus.

ago, and who had characteristic symptoms of cerebellar abscess, including choked disks with retinitis, removal of granulations from the middle ears, with the establishment of proper drainage, effected a cure. The choked disks and retinitis disappeared.

Babinski has described certain difficulties in the normal movements of pronation and supination in cases of cerebellar abscess. The patient tries to perform the movement of pronation and supination, but does so with much difficulty with the hand on the side of the lesion.

Overpointing is another symptom of importance and consists in having the patient place the forefinger of his hand, corresponding to the affected side, on the finger of the surgeon. The patient is then asked to raise or lower the finger and then touch the finger of the surgeon. He is able to do this quite well while his eyes are open, but when his eyes are closed, instead of his finger returning to its original position, as would be the case in a normal person, there is an outward deviation toward the affected side.

I have reported a case of cerebellar abscess[1] in which I not only removed a button of bone at point *G*, Fig. 148, having first laid bare with chisels the sigmoid sinus, but I also trephined the skull at point *C*, to investigate the temporo-sphenoidal lobe and the upper wall of the tympanic cavity. The case was that of a male, aged thirty-one years, who had had a purulent discharge from the right ear for five years. When admitted to the hospital the prominent symptoms were nausea, vomiting, and vertigo. The vertigo was not only present when lying down, but was much more marked when he tried to stand. He also complained of severe pain in the head. He had a staggering gait from the first with, an inclination to fall toward the left. Other symptoms were facial paralysis (right side), œdema of the right optic nerve, slow pulse, and a temperature but slightly above normal. At the autopsy an abscess was found in the right cerebellar hemisphere (see Plate II).

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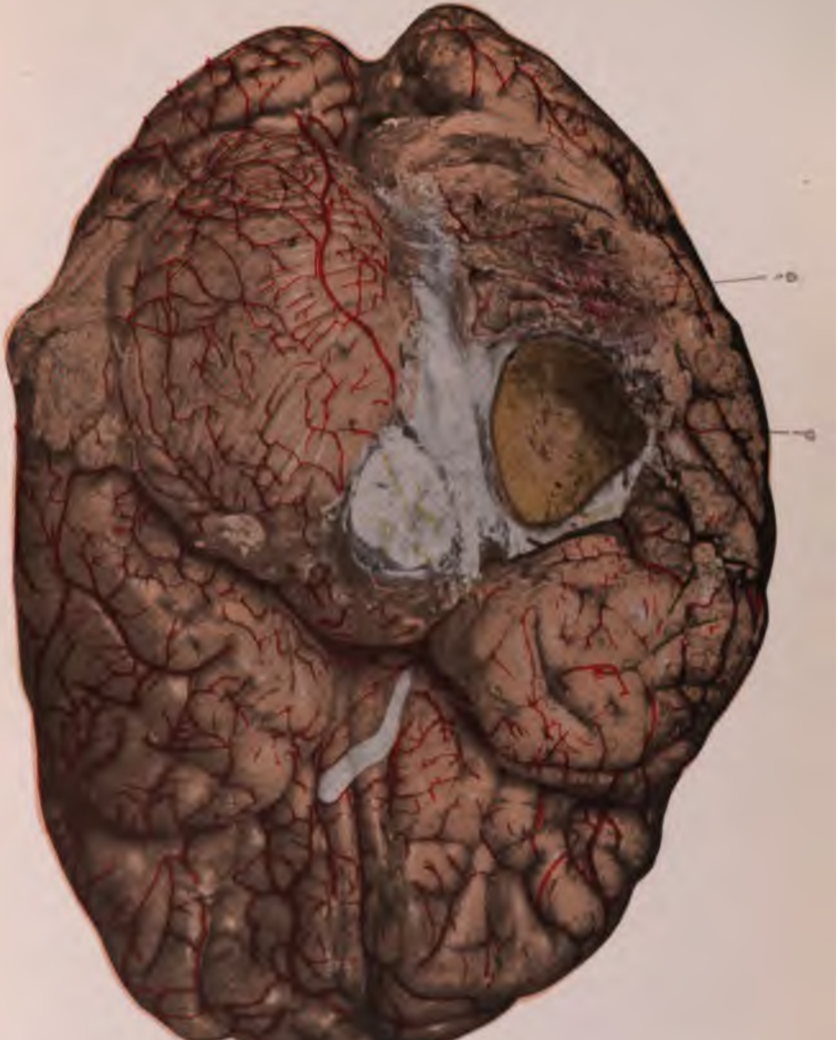
[1] American Journal of the Medical Sciences, August, 1895.

Other symptoms of cerebellar abscess sometimes observed are: slowing of the respiration; Cheyne-Stokes respiration; repeated yawnings; slowness of cerebration and general apathy; irritability and intolerance of light; delirium; rigidity of the neck and retraction of the head; clenching of the teeth from rigidity of the muscles; nystagmus; motor or sensory paralysis. According to Bárány, if there is rotary nystagmus toward the affected side and there is no longer any irritability of the labyrinth, one can be reasonably sure of the existence of a cerebellar abscess, provided the patient has a low temperature and a slow pulse. Nystagmus, in cases of cerebellar abscess, always becomes more marked as the disease advances, and is always greater toward the affected side. If the medulla is affected at a point low enough, the paralysis may be unilateral and on the same side as the abscess. If, however, the pons is involved more on the side of the abscess, the paralysis will be apparent on the opposite side. Neumann, of Vienna, has collected the data of 132 cases of cerebellar abscess following chronic suppurative otitis media, and in the majority of these cases the path of the infection was through the labyrinth.

When there is a cerebellar abscess together with sinus

PLATE II



Abscess of cerebellum secondary to chronic suppurative otitis media. The right cerebellar hemisphere has been divided and the lower half removed, exposing the abscess cavity and its wall *(a)* and the area of hemorrhagic softening posterior to the abscess *(b)*.

thrombosis there may be rigors or chills, with high temperature and tenderness along the course of the jugular vein, if that vessel is affected. Suppurative leptomeningitis is another complication which may occur and thus render the diagnosis more difficult. Diffuse leptomeningitis gives rise to high temperature (without remissions, which are characteristic of infective sinus thrombosis), a rapid pulse, general irritability, and with the special senses very acute.

Considerable attention is being devoted to the subject of *leucocytosis*, a term used to signify an abnormal increase in the number of leucocytes present in the blood of patients suffering from various affections, with the result that it has been shown to exist in suppurative affections of the ears. Daily examinations of the blood should be made in order to determine whether the leucocytosis is increasing or decreasing, and what relative changes are taking place in the cell percentage. For example, if the leucocytosis is falling, and the polynuclear percentage is above normal (68) and rising, the prognosis is not so good as when both are falling, or when the leucocytosis is increasing and the polynuclear percentage is falling. Or, as tersely put in Sondern's axiom, "the increase in the relative number of polynuclear cells is a direct indication of the severity of the toxic infection and the degree of leucocytosis an absolute indication of the body resistance toward the infection."

No hard-and-fast rules can be laid down to aid the aural surgeon. According to a study of acute and chronic purulent otitis media, with and without complications, made by Dixon at the New York Eye and Ear Infirmary, it was found that the leucocytosis in those cases with mastoiditis as a complication ranged from 5000 to

17,800, and the average polynuclear percentage was within normal limits. It was not until the more serious complications occurred, such as epidural abscess, sinus thrombosis, and intracranial invasion, that the blood count began to have any very marked significance.

While the above is true in the main, conclusions drawn from blood counts should be guarded. A most important point to start from would be a knowledge of the normal average leucocyte count and cell percentage in each individual. Impractical as this may appear, I feel it to be the only rational basis from which to draw conclusions in individual cases. For instance, in sinus thrombosis the leucocytes ranged from 5200 to 22,400 (one case 36,400, in which there may have been a complicating meningitis), the average being 12,270.

Forty-two per cent. were under 10,000; 32 per cent., 10,000 to 15,000; 8 per cent., 15,000 to 18,000; 10 per cent., 18,000 to 20,000, and 8 per cent., over 20,000.

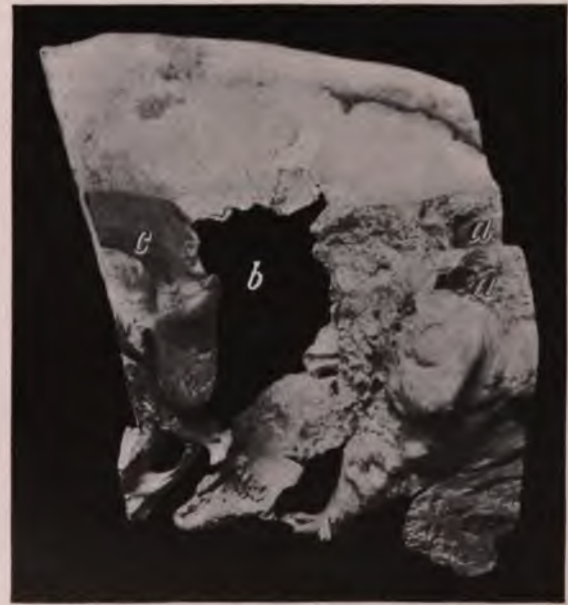
The highest polymorphonuclear count was 95 per cent., and the lowest 46.6 per cent., the average being 77.6 per cent. Grouping these counts similarly to the leucocyte count, it was found that 22 per cent. were under 70 per cent.; 32 per cent., 70 to 80 per cent.; 16 per cent., 80 to 85 per cent.; 22 per cent., 85 to 90 per cent., and only 8 per cent. of the cases were over 90 per cent.

In meningitis the count ran somewhat higher, the highest leucocyte count being 41,600, and the highest polymorphonuclear count 95.5 per cent. The lowest was 4200 leucocytes with 48 per cent. polynuclear. This very unusual count was maintained throughout the illness of this patient, and he finally died. If this case be left out, Dixon found the average leucocytosis to be

27,280, and the average polymorphonuclear count 87.6 per cent.

In brain abscess the counts were more nearly those of sinus thrombosis. The average leucocytosis was 14,900, and the average polymorphonuclear count was 77 per cent.

FIG. 175.



Left temporal bone of a patient who died of cerebral abscess. *a, a.* Openings in the sclerosed mastoid process, made with chisels. *b.* Large carious opening leading into the middle cerebral fossa. *c.* Zygoma.

The reader is referred to works dealing with the subject of blood examinations for information as to the various methods of determining the number of cells, the hæmoglobin percentage, etc.

In 1888 an operation for cerebral abscess following disease of the ear was performed by Dr. Robert F. Weir and myself. The patient[1] was under my care at the New York Eye and Ear Infirmary for chronic suppurative otitis media, with extensive necrosis of the temporal bone. He had had a purulent discharge from the ear for the preceding two years. The mastoid process was opened in two places (see Fig. 175), and was found very dense, but did not contain pus. Subsequently an abscess was located in the temporo-sphenoidal lobe and the pus evacuated. The patient's condition improved for a time, but later he passed into a comatose condition. The immediate cause of death was secondary hemorrhage from a vessel in the brain.

That a patient may have a brain abscess, with few, if any, characteristic symptoms of the disease, is shown in the report of the following case : the patient, colored, aged twenty-one years, was admitted to my clinic, and said that for a year the left ear had been discharging. There was no trouble with the right ear. Two weeks ago the left ear began to pain him, and the discharge became more profuse. There was pain also in the region of the left mastoid and all over the head. The severe headache seemed to be the most prominent symptom, and there was also a slight rigidity of the neck. His breath was very bad. Temperature, 100.2° F.; pulse, 80; respirations, 24. There was no dizziness, no nystagmus nor aphasia. His mind was perfectly clear. There was exquisite tenderness over the entire mastoid process. There was a foul-smelling discharge from the ear, the auditory canal was red and swollen, and there was a small polypus attached at the inner end. The usual mastoid operation was performed, and the dura over the tympanum was found thickened, with a small sinus leading to a large abscess in the temporo-sphenoidal lobe. The abscess was opened and a cigarette-drain was inserted. The patient at first was much better, and it was difficult to keep him quiet in bed. The abscess cavity was not irrigated at any time. Lumbar puncture was done repeatedly. The fluid was clear, but under considerable pressure. Cultivations were negative. As the patient was not doing well and complained of headache again, I explored the wound and evacuated considerable pus by means of the Whiting encephaloscope. After the operation the patient rapidly grew worse, and died six days later. Just before death the temperature rose to 106° F.; pulse, 140; respirations, 64.

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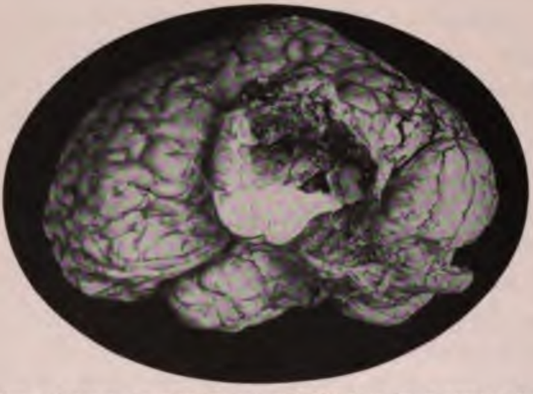
[1] Transactions of the American Otological Society, 1888.

Autopsy. The dura showed nothing except some congestion, but when it was removed both cerebral hemispheres were found bathed in thick, creamy pus. There was some pus at the base and in the upper part of the spinal canal; but after the brain had been removed the canal seemed to be dry and free from pus, but there were no very marked adhesions about the foramen magnum. There was a large abscess cavity in the left temporo-sphenoidal lobe at the site of the opening through the temporal bone, previously made for the drainage of the abscess. Cause of death, purulent meningitis. The meningeal pus showed long-chain streptococcus. The abscess cavity occupied the position of the second and third convolutions of the left temporo-sphenoidal lobe, beginning as far forward as the tip of the lateral ventricle. It measured 53 mm. × 30 mm. from before backward and from without inward, respectively, and about 15 mm. from above downward. The abscess had broken into the lateral ventricle 17 mm. behind the tip of the anterior horn (Fig. 176).

This case is only one of many that are seen, and if we wait for the so-called classical symptoms of brain abscess, we shall fail in many instances to make a diagnosis. In this patient, the only symptoms suggestive of an intracranial complication were the headache, slight rigidity of the neck, and the foul breath and coated tongue, and the extensive mastoid tenderness. There was a moderate leucocytosis, and the polynuclear count was increased. There was absence of aphasia, and the temperature was not subnormal and the pulse slow, as we often see in such cases. In the light of the autopsy it is most probable that the patient had purulent meningitis, as well as the brain abscess, when he entered the hospital. A private patient recently came under my care who had a chronic otorrhea and mastoid disease.

Fig. 176.



Entire floor of abscess cavity incised and lifted to show extent of cavity and its communication with the lateral ventricle.

The mastoid cells were opened and subsequently she had a septic thrombus in the sigmoid sinus extending into the internal jugular vein. The thrombus was removed and the internal jugular vein was excised. Later purulent meningitis developed and she died. When first seen she had a slight rigidity of the muscles of the neck, but never marked enough to make one feel that she had a latent meningitis, as there were no other symptoms present which were characteristic of that disease. I believe now that she had a commencing meningitis at that time, and that the patient could not have been saved by any operation.

The difficulties of making a diagnosis of an intracranial complication are clearly shown in the report of the following case: A young man, a law-student at Columbia University, came under my care, suffering from a supposed attack of influenza. He had an acute suppuration of both middle ears, followed by a mastoid operation. The temperature rose, and the patient developed symptoms which were suggestive of a temporo-sphenoidal abscess or sinus thrombosis, but not at all characteristic of either disease. The respirations became very slow, only eight per minute, and he was very dull and drowsy. The meningococcus of Weichselbaum was found in the discharge. I felt that something must be done at once, so I explored the sigmoid sinus and temporo-sphenoidal lobe, but with a negative result. The day following the operation the patient was very much better, and he gradually recovered. The only explanation that seemed to me at all plausible was that it was a case of beginning meningitis, and that the local depletion arrested the disease, as there was considerable hemorrhage.

When not interfered with by operative measures, a cerebral abscess terminates, as a rule, in death. The patient may pass gradually into a comatose condition, while the pus escapes on to the surface of the brain or bursts into the ventricles. When the pus reaches the surface of the brain a new inflammatory action is set up, leading possibly to acute leptomeningitis. As a result the temperature becomes high and the pulse rapid. Other symptoms are vomiting, restlessness, rigidity of the limbs, great weakness, and clonic spasms. When the pus bursts into the ventricles the patient's condition changes at once. The temperature rises suddenly to 104° or 105° F.; the pulse becomes very rapid; the respirations are increased in frequency; muscular twitchings occur, followed by convulsions, coma, and death.

Abscesses have become encapsulated and remained quiescent for years without giving rise to serious trouble, but such instances are extremely infrequent. Cases have been reported also in which abscesses in the temporo-sphenoidal lobe have drained through a carious opening in the tegmen tympani, and the pus has escaped through the external meatus. A cerebellar abscess has also been reported where the pus forced its way through a carious opening in the sigmoid groove, the sinus having been destroyed. Occasionally, but very rarely, an abscess may drain in this way and be followed by recovery. One should never for a moment anticipate such a result, for the time to operate successfully is at an early date, before the patient has passed into a comatose condition.

It is frequently very difficult to make a differential diagnosis between cerebral abscess, sinus thrombosis, and meningitis, as at times one or more of these diseases may occur in the same case.

It is not often that a patient has an abscess in the temporo-sphenoidal lobe and also one in the cerebellum, but such a case[1] came under my observation. The patient was a woman, thirty-two years of age, who had suffered from a chronic discharge from the right ear, and whose hearing in consequence had been defective for some years. For a month before she came under my care she complained of pain in the right ear and severe pains in her head. She also had vertigo and general weakness, and nine days before admission to the hospital she had two distinct chills on the same day, followed by vomiting. The mastoid cells were opened, and were found diseased. Later the temporo-sphenoidal lobe was investigated on the right side for an abscess, on account of the following symptoms, viz., paralysis of left abducens; paralysis of left side of face; slight left hemiparesis; moderate left hemianæsthesia; left homonymous hemianopsia; choked disks on both sides. The bone was cut away from the external auditory canal in a direction upward for a distance of two inches, so that the brain in the middle fossa could thoroughly be exposed. The dura was found thickened and bulging, and a minute opening was discovered about an inch and a half above the external auditory canal, leading in a direction inward, upward, and backward for at least three inches, and disclosing an abscess cavity. The patient seemed to do well immediately after the operation. A few days later, however, she developed muscular twitchings of the face and legs. She also became slightly delirious and tried to remove the bandages. The muscular twitchings persisted, and affected the right side of the face, right arm, and leg. At times the patient for the next few days was rational and quiet; then again she would scream out and try to tear off the bandages. During this time the temperature varied from 98.4° to 102° F., pulse 80–110, respirations 18–24, showing a course exceptional to that usually observed in cases of brain abscess. At the autopsy nothing unusual was observed about the meninges. There was, however, a large abscess cavity in the temporo-sphenoidal lobe, which had been well drained. On opening the right lobe of the cerebellum, an abscess was disclosed, containing about half an ounce of dark foul-smelling pus. It appeared to have had its origin in the dentate body, which it destroyed. It then extended across to the opposite lobe, which it invaded to the extent of half an inch. No communication whatever could be found between the abscess in the cerebellum and that in the temporo-sphenoidal lobe. This case demonstrated the fact that a chronic purulent otitis media may remain quiescent for many years, when suddenly the patient complains of excruciating pains in the head and ear, and general weakness, followed by vomiting, vertigo, chills, and an intracranial complication.

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[1] Transactions of the American Otological Society, 1900, vol. xxx. part iii.

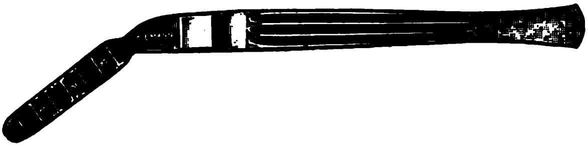
It is impossible to know the percentage of recoveries of brain abscesses, for, as a rule, all successful cases are reported, but the same cannot be said of unsuccessful ones. According to Kœrner's records recovery has occurred in 50.2 per cent. of cases of cerebral abscess, and in 52.8 per cent. of cerebellar abscess. In ninety cases reported by Kœrner, sixty were males. Of one hundred and thirty-nine cases of sinus thrombosis, including some that have not been recorded as yet, ninety-five terminated in recovery. Of forty-two cases reported at the New York Eye and Ear Infirmary, there were thirty-three recoveries and but nine deaths, so that the surgeon is fully justified in operating. An exploratory operation whereby the dura is exposed and an instrument introduced into the lateral lobe of the cerebellum or temporo-sphenoidal lobe is attended with but little risk to the patient if aseptic precautions are carefully followed out.

Treatment. In all operations on the mastoid antrum and cells, and when opening the cranial cavity, the most thorough antiseptic precautions should be followed. The ear should thoroughly be syringed with bichloride solution, 1 : 5000, and then carefully dried and a strip of sterile gauze pushed down into the meatus. The hair should be shaved about the ear for a considerable area. The mastoid region and the surrounding parts should then be scrubbed with green soap and water, and afterward with pure alcohol, or sulphuric ether, or bichloride solution, 1 : 3000. Dry sterile towels should then be placed over the patient's face and shoulders, and a sterile towel wrapped around the head and fastened with a safety pin or artery forceps. All instruments should be sterilized. The blades of the scalpels should be dipped into absolute alcohol, and carbolic solution, 1 : 20.

The surgeon should open the mastoid antrum first (see Fig. 125), and make this the starting-point of the operation, for it is in this cavity that the micro-organisms exist, and where they rapidly fructify as long as the soil is fertile. Antiseptics injected into the middle ear do not reach them. Beside scalpels and retractors, it will be necessary to have a mallet, gouges and chisels of different sizes, a periosteal elevator, forceps for controlling hemorrhage, rongeur forceps of different sizes, probes, and exploring needles. After removing all cheesy matter and granulations from the antrum, and excising the ossicles if carious, the condition of the tegmen tympani and tegmen antri should be investigated. If a sinus is found leading to the middle cranial fossa, it should be enlarged, and pus, if present (extradural abscess), evacuated. The surgeon should examine the condition of the dura before injecting any solution into the extradural cavity. The latter cavity may be washed out safely with the normal salt solution or a saturated boric acid solution, provided no opening exists in the dura which leads into the pia mater or brain itself. It is best to do but little irrigation, for fear of disseminating the morbid products. The cavity should be dusted over with equal parts of boric acid and iodoform, and sterile gauze should be inserted into the wound, so that it may fill up with granulation-tissue. When pus is seen to ooze from an opening in the dura, or one has reason to suspect a temporo-sphenoidal abscess, the surgeon should extend the previous incision (for exposing the antrum) in a direction upward and then forward around the upper border of the auricle, thus dividing the temporal artery (see Fig. 147, from point 2 to point 4). The hemorrhage is controlled easily by means of a ligature. Another incision should be made in a direction upward (from point 2 to point 5), and the flaps dissected so as to give the surgeon plenty of room. If the bone just above the external meatus is not too dense, it should be cut away rapidly with large chisels and bone forceps, and the opening enlarged so that the dura can be fully exposed. In some cases, especially where the bone is very dense or the patient is in such a condition that it is necessary to explore the temporo-sphenoidal lobe as rapidly as possible, a disk of bone should be removed with a trephine, the centre-pin of the trephine being placed at the point *C*, Fig. 147, a distance of an inch and a quarter above the centre of the external bony meatus. The trephine opening should be at least three-quarters of an inch in diameter. It is probable that most abscesses in this region are the result of inflammation extending from disease of the antrum. It is, therefore, best to attack the abscess cavity at this point (antrum), and to enlarge the opening in a direction upward, in order to secure the best possible drainage. From this region, also, a large exploring needle may be introduced into the temporo-sphenoidal lobe if a brain abscess is suspected, after a circular flap has been made in the dura. As the pus is often very thick I have been in the habit lately of introducing a director in different directions in the brain substance. The instrument devised by Horsley is better adapted for this purpose than the exploring needle, as it consists of two blades, resembling an ear speculum. which can be separated after introduction, thus affording the surgeon a view of the abscess cavity. The blades can be pushed gently through brain tissue without the use of a knife, until at least the capsule of the abscess is reached. After the abscess cavity has been detected, a free opening should be made in the dura with a scalpel, and if possible the surgeon should enlarge the incision in the brain tissue with a director, for fear of injuring some bloodvessel. A free incision may, however, be made in the temporal lobe with a scalpel if the bloodvessels are carefully avoided; or, better still, with the knife devised by Urbantschitsch, of Vienna. (See Fig. 177.)

Cerebral pulsation may not be evident if the abscess is small and deeply seated. There may, however, be entire absence of pulsation even if the abscess is near the surface and the dura protrudes through the bony opening. After making an opening down to the abscess, great care should be exercised in evacuating the pus and sloughs for fear of damaging the healthy brain tissue.

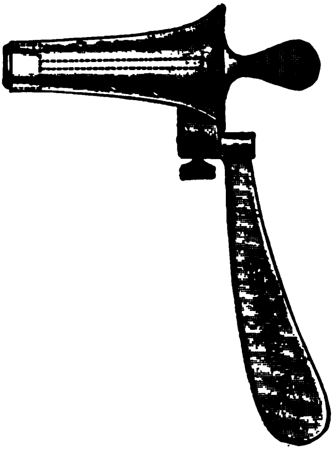
FIG. 177.



Urbantschitsch's brain knife.

The surgeon should endeavor to remove all the sloughs, otherwise the cavity is likely to refill with pus. After the abscess has been opened the encephaloscope devised by Dr. Fred Whiting, of New York, can be used to advantage. It is much like an ordinary ear speculum but larger (Fig. 178), the extremity being closed by an obturator so that it can be pushed into the abscess cavity without effort, and thus any laceration of the brain substance can be avoided. The instrument is used with a head-mirror. It should be introduced first for a short distance only and then the obturator should be removed with a slight rotary movement, and at the bottom of the encephaloscope can be seen a meniscus which points toward the abscess so that the direction of the abscess path can readily be determined. According to Whiting, the surgeon can decide whether he is dealing with a single abscess cavity or a large abscess path communicating with several other abscesses—and mechanically the instrument enables the operator to introduce gauze into the abscess cavity without any risk of tearing the abscess wall and carrying infection into healthy brain tissue. The cavity may then be washed out most gently with a boric acid solution or a 1 : 100 carbolic solution by means of a double canula, the tube carrying away the fluid from the abscess cavity being a little larger than the other one. But little force should be employed in syringing, otherwise great damage may be done to the brain tissue. The irrigation of the abscess cavity should be limited to those

FIG. 178.



Whiting's Encephaloscope.

cases in which the walls are firm or else are lined with a capsule. As a general rule it is better not to irrigate the cavity of an acute brain abscess. After evacuating the abscess cavity, strips of iodoform gauze should be packed in loosely for the purpose of draining it. These may have to be changed every day at first, but later less frequently. Under such frequent dressings, boric acid or sterile gauze should be substituted, for fear of the toxic effect of iodoform. H. P. Mosher,[1] of Boston, has used in cases of brain abscess a wire gauze drain, made of copper wire gauze of a fairly wide mesh. "This drain," he says, "catches in the granulations at the edge of the skin wound and holds in place almost too well. The copper gauze allows the operator to bend the drain as he pleases. For insertion the drain is closed by a plunger. The natural shape of the drain is a cone. If the drain is kept clean it serves in a measure the purpose of an encephaloscope, as the brain substance or the wall of the brain abscess can be seen to a certain extent through the meshes of the wire gauze. The combined use of this drain and glycerin gives a brain drain which seems to drain." Mosher modified a drain which he had seen in France while a member of the British Army Medical Corps. "The British army drain is a metal tube closely studded with perforations. It is kept filled with glycerin and the gauze over it is also saturated with glycerin. The object of this is to soften the necrotic brain tissue and to keep the pus liquid so that both the cast off brain substance and pus can make their way into the tube. Each day the contents of the drain are removed with a small curette." The author has been in the habit, however, of using a gauze or cigarette drain in these cases, while some surgeons advocate a drain of folded rubber tissue. Outside of the abscess the wound after aseptic irrigation, should be covered first with several layers of iodoform gauze, and then with a pad of sterile gauze. Outside of this a thick layer of absorbent cotton should be placed, and the whole should then be bandaged.

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[1] Transactions American Otol. Soc., 1916.

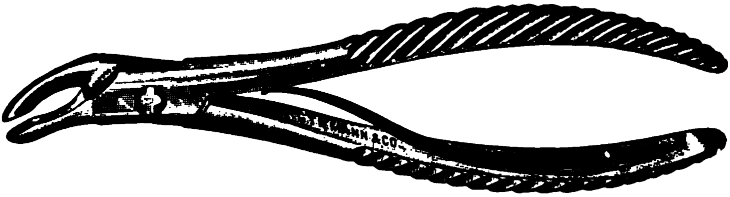
After several days, in the case of a chronic abscess, when the walls have become firm, a 1 : 5000 bichloride solution may be injected into the abscess cavity to advantage. In a case of mine which recovered, and in which streptococci were found, great improvement ensued after using a bichloride solution.

In the case of a cerebellar abscess, it is always advisable to expose first the sigmoid sinus, as the latter frequently is thrombosed. A horizontal incision should then be made in the soft parts and carried backward (see Fig. 147, from line of original mastoid incision to point 3), so as to give the surgeon plenty of room not only to lay bare the sinus, but also to cut away with ronguer forceps the bone lying to the outer and external aspect of the sinus, and reach the abscess in that way. Otherwise the treatment is identical with that already described (abscess in the temporo-sphenoidal lobe).

If the bone is very dense, and for any reason it becomes necessary to explore the cerebellum for an abscess without first investigating the sigmoid sinus, the following method of procedure should be followed: A button of bone should be removed with a trephine (see Fig. 174) by placing the centre-pin of the instrument at a point, *G*, a distance of two inches behind and one-quarter of an inch below the centre of the external auditory meatus. As shown in the same figure, Reid's base-line extends from the lower margin of the orbit through the centre of the external auditory meatus. The directions which formerly were given for exposing the sigmoid sinus by means of the trephine were to remove a button of bone by placing the centre-pin of the trephine at point *F*, a distance of one inch behind and one-quarter of an inch above the centre of the external meatus.

Macewen[1] says that the intermediate path in an abscess of the brain as well as the primary focus must be eradicated—otherwise a secondary abscess will result. Therefore, whenever a delay of twenty-four hours is possible after the mastoid operation and exposure of the dura, he introduces small pieces of gauze soaked in a 5 per cent. solution of carbolic acid between the dura and the bone to induce adhesions. These are formed generally in twenty-four hours. The abscess is then opened.

FIG. 179.



Author's ronguer forceps.

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[1] **Transactions of the Seventh International Otological Congress, Bordeaux, 1904.**

THROMBOSIS OF THE SIGMOID AND OTHER SINUSES.

Before describing the symptoms of sinus thrombosis, it is important to review in a general way the gross anatomy of the brain, particularly as to its venous supply.

The superior cerebral veins collect the blood from the upper portions of the cerebrum, and after anastomosing with one another and the inferior cerebral veins, empty into the superior longitudinal sinus. The inferior cerebral veins enter the lateral, cavernous, and superior petrosal sinuses. The middle cerebral vein, after being joined by branches from the frontal and temporo-sphenoidal lobes, pours its blood into the cavernous sinus.

The *sigmoid sinus* is a continuation of the lateral sinus, and is that portion which lies in the sigmoid groove. It is joined by the inferior petrosal sinus and forms the *internal jugular vein.* The sigmoid sinus receives blood from the superior petrosal and occipital sinuses, also from the superior longitudinal and straight sinuses by means of the lateral sinus. The lateral and sigmoid sinuses, together with the internal jugular vein, are of especial interest to the aural surgeon, for it is in these vessels that most frequently a thrombus is found when the middle ear and mastoid cells are involved, although the other sinuses that are in communication with them are liable to be affected, especially the superior and inferior petrosals.

Small veins from the mastoid cells and tympanum also enter the sigmoid sinus, more especially at that point called the knee or the anterior convexity of the sinus. A *mastoid vein* joins the sigmoid sinus at its posterior aspect, and frequently is thrombosed when the former is involved. A thrombus forming in the sigmoid sinus may not only extend to the petrosals, but even to the cavernous sinus as well. Although not constant, there is a communication between the vessels of the external portions of the skull and the sigmoid sinus by means of the mastoid and posterior condylar veins. The latter connect the sigmoid sinus with the vertebral veins and the deep veins in the posterior part of the neck.

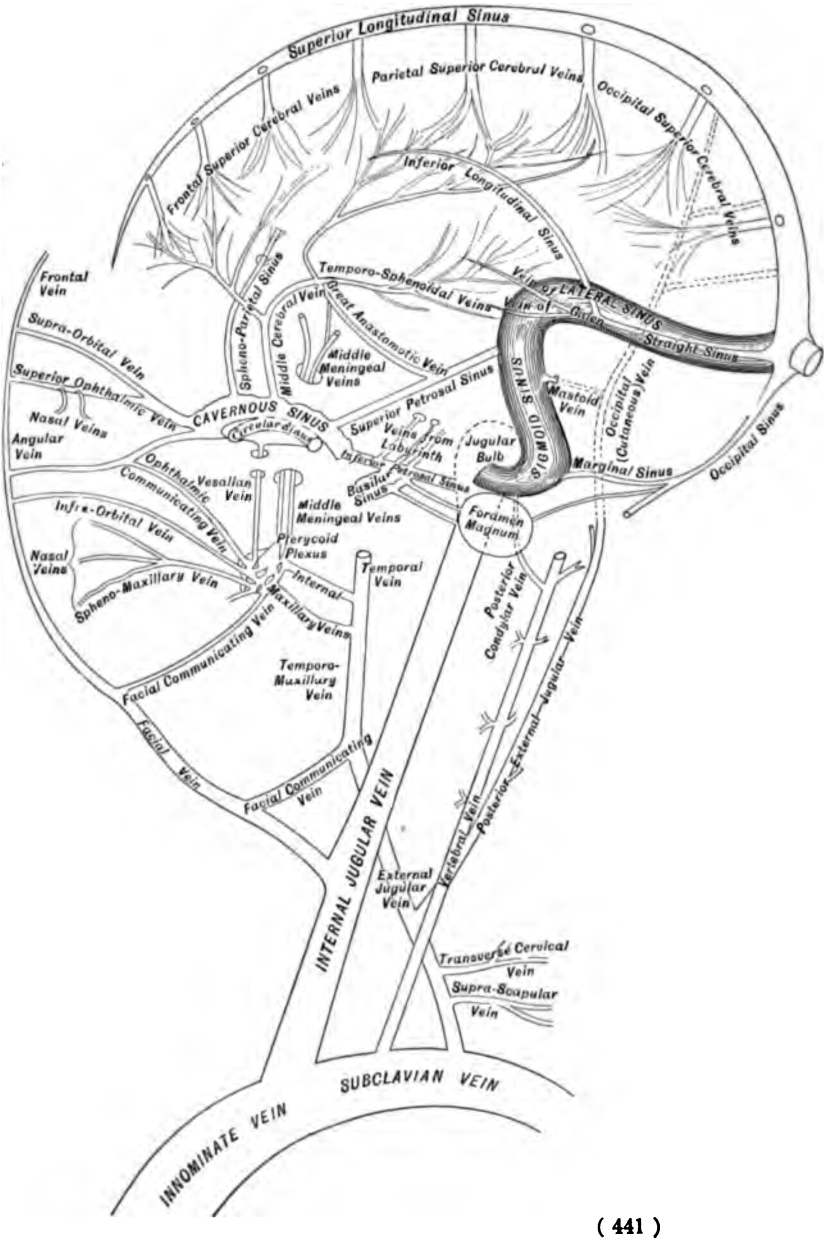
Lymphatics. The lymphatics in the scalp enter the mastoid, parotid, and occipital lymphatic glands. Some of the lymphatics of the face are superficial and others deep. The deeper ones terminate in the internal maxillary glands, while the superficial ones join the submaxillary and parotid lymphatic glands.

The lymphatics within the cranial cavity are situated in the pia mater and choroid plexus, taking their exit from the cranial cavity along the internal carotid and vertebral arteries and internal jugular vein, and join the deep cervical glands, so that the latter glands are liable to be enlarged when there is some irritation or inflammation within the cranium. Being deeply seated, they are liable to escape detection.

From this brief review of the anatomy it will be possible to understand more readily the pathology and symptomatology of sinus thrombosis.

A thrombus may be *primary* or *marasmic*, as well as *secondary* or *infective*. The marasmic is said to occur almost always in the longitudinal sinus, very seldom in either the lateral or cavernous sinus. It is observed in the very young and in the aged, and is developed generally during the course of some wasting disease, such as chronic diarrhœa, pneumonia, tuberculosis, and car-

FIG. 180.


Superior Longitudinal Sinus
Parietal Superior Cerebral Veins
Occipital Superior Cerebral Veins
Frontal Superior Cerebral Veins
Inferior Longitudinal Sinus
Temporo-Sphenoidal Veins
Vein of Galen
LATERAL SINUS
Straight Sinus
Great Anastomotic Vein
Middle Cerebral Vein
Spheno-Parietal Sinus
Middle Meningeal Veins
Frontal Vein
Supra-Orbital Vein
Superior Ophthalmic Vein
Nasal Veins
Angular Vein
CAVERNOUS SINUS
Circular Sinus
Superior Petrosal Sinus
SIGMOID SINUS
Mastoid Vein
Occipital (Cutaneous) Vein
Veins from Labyrinth
Jugular Bulb
Inferior Petrosal Sinus
Marginal Sinus
Occipital Sinus
Ophthalmic Communicating Vein
Vesalian Vein
Basilar Sinus
Foramen Magnum
Middle Meningeal Veins
Infra-Orbital Vein
Pterygoid Plexus
Nasal Veins
Spheno-Maxillary Vein
Internal Maxillary Veins
Temporal Vein
Posterior Condylar Vein
Facial Communicating Vein
Temporo-Maxillary Vein
Facial Vein
Facial Communicating Vein
INTERNAL JUGULAR VEIN
Vertebral Vein
Posterior External Jugular Vein
External Jugular Vein
Transverse Cervical Vein
Supra-Scapular Vein
SUBCLAVIAN VEIN
INNOMINATE VEIN

cinoma. The heart's action becoming weakened and the blood being thickened, there is a tendency for coagulation to occur.

It is the *infective* or inflammatory thrombus that concerns the aural surgeon, and which is due to the presence of a pathogenic microörganism, the sigmoid sinus being affected most frequently on account of its anatomical relation to the temporal bone, more especially the mastoid cells. Infective thrombosis is observed seldom in children and aged persons. It may be due to fractures of the skull, scalp-wounds, anthrax affecting the lips, mouth, or orbital or nasal cavities, and erysipelas of the face and head. Middle-ear disease and mastoid inflammation are the most frequent causes. The thrombosis is due to the presence of pathogenic microörganisms, such as the staphylococcus, the streptococcus, the pneumococcus, or the bacillus mucosus capsulatus. They may exist alone or together in the same case. Experience teaches that the streptococcus is the most virulent and gives rise to serious symptoms, and the bacillus mucosus capsulatus is the most insidious. The infection may be due to direct extension of the inflammation in the bone to the sinus walls, whereby they become inflamed and thickened, and a thrombus forms in the interior of the sinus. There may, however, be fissures in the tympanic roof or antrum through which the infection travels, or small veins in the bone, joining with the sigmoid, become thrombosed and convey the morbid products in this manner. The most frequent cause, however, is by direct contact with the diseased bone.

When the sinus first is affected the endothelium becomes swollen and desquamates, and coagulation takes place. The deposit of fibrin may be limited to one side of the wall (parietal clot), or the whole circumference of the vessel may be involved (obstructing thrombus). After this the clot, as a rule, breaks down, so that pus is formed, and, being filled with microörganisms, the latter are likely to be carried into the general circulation. Ulceration may take place on the wall of the sinus, but hemorrhage does not usually follow, because the thrombi formed above and below this point are firm enough to prevent the escape of blood. The infective material may also be carried by the tributary veins in the neighborhood of the thrombus into the general circulation. In some cases a partial re-establishment of the current takes place through the thrombus, by which means the pathogenic material is swept into the general blood-current. Another way in which general infection takes place is by the escape of morbid products through the sinus walls into the surrounding parts, so that another focus of infection is established whereby micro-organisms are carried into the circulation through the perivascular spaces and congested vessels.

It is probable also that the pyogenic micro-organisms may give rise to general infection through absorption by means of the lymphatics. The streptococcus is found most frequently in the lymph-vessels. As a result of thrombosis of the sigmoid sinus the same phenomena frequently occur in the internal jugular vein, especially its upper portion, as well as occasionally in the superior petrosal and cavernous sinuses and the anterior and posterior condylar veins. A large number of internal jugular veins, excised at the New York Eye and Ear Infirmary, have been examined microscopically and found to contain micro-organisms in the wall, but rarely were demonstrable in the clot itself.

When a thrombus forms within the sinus certain changes take place in its walls, owing to a peripheral exudation of plastic material which would tend to strengthen the weakened wall if the tissue should become changed into connective tissue. The same, if it occurred on the wall next to the brain cavity, would also help to prevent the occurrence of leptomeningitis through the formation of firm adhesions between the dura and membranes. Unfortunately, such is not the rule, as the plastic material is apt to break down and increase the dangers of infection. When, through ulceration of the sinus wall, an opening occurs, the pus may find its way through the mastoid foramen and form an abscess in the tissues in the posterior portion of the mastoid process. As a result of infection of the posterior condylar veins an abscess may develop beneath the deep fascia in the posterior cervical triangle. In consequence of involvement of the visceral layer of the sinus, acute leptomeningitis is the rule, although in some instances the meningitis becomes localized.

When the thrombus breaks down, the bone in its vicinity becomes of a dark-brownish or greenish color, very much softened and eroded. The discoloration or pigmentation is so marked in some instances that the course of the lateral or sigmoid sinus becomes stamped on the cerebellum itself. When the thrombus disintegrates, the infective particles generally are transmitted first to the small vessels in the lungs, so that infarctions occur, and as a result there may be an infective pneumonia or gangrene. The pleura, pericardium, brain, kidneys, and liver may also be affected in the same way, or an abscess may form in the cerebrum or cerebellum as a result of thrombosis from extension of the infective processes.

Instead of disintegration of a thrombus, the latter, in rare instances, becomes organized; and in such cases the same reparative inflammation takes place as in other organs of the body.

When the infective process has been slight, the obliteration of the sinus may be established at that point by means of fibrous tissue, as the result of the formation of granulations on the walls of the sinus and adjacent dura, which penetrate into the sinus itself as well as the surrounding bony tissue. Such granulations tend to prevent the entrance of infective material into the sinus.

Symptoms. The symptoms should be divided into (1) local and (2) general or systemic.

1. *Local.* A profuse discharge from the ear often becomes diminished in quantity. Pain is generally present, being slight in some instances, while in others it radiates over the side of the head and is excruciating. As the mastoid cells usually are affected at the same time, there is more or less pain when pressure is made on the different portions of the mastoid process, and especially in the neighborhood of the sinus and over that point where the mastoid vein enters the skull.

Œdema of the superficial tissues about the mastoid tip, extending to the region of the mastoid vein and also to the upper portion of the posterior cervical triangle (Griesenger symptom), with tenderness on pressure over this area, is another symptom of importance, although the same condition of affairs exists in uncomplicated mastoid disease, especially when perforation has occurred at the mastoid tip (Bezold perforation).

When the thrombus has extended to the cavernous sinus and the ophthalmic vein has become engorged, there is likely to be a certain amount of œdema of the eyelids and exophthalmos on the corresponding side.

The enlargement of both superficial and deep cervical glands is a symptom that cannot be relied upon. In some cases it is present, but absent in others. When the mastoid vein has not become involved, and the thrombus is located in the lower portion of the sigmoid sinus, there may be an over-distention of the mastoid vein. In some instances it has been noted that the veins on the other side of the head were more dilated than usual, owing to increased pressure. Not only is there tenderness on pressure in the upper third of the posterior cervical triangle, but also very frequently along the course of the internal jugular vein, especially in its upper portion, when the latter has become involved. This is, however, one of the later symptoms. The patient generally has an anxious and pallid appearance, with beads of perspiration standing out on the face and forehead.

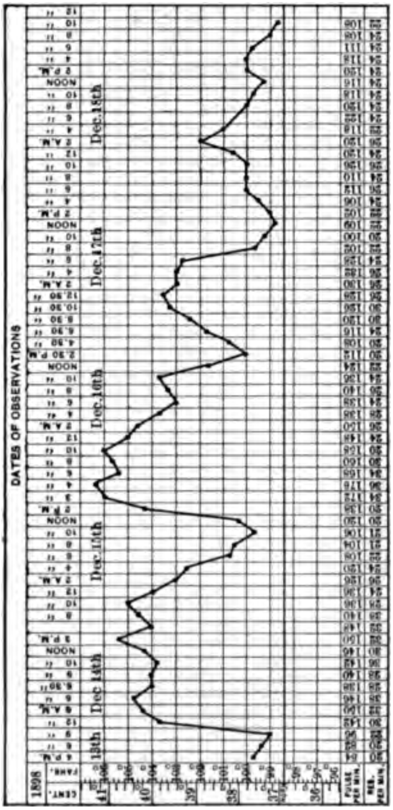
As a result of infective thrombosis, the tissues in the cervical region become œdematous and filled with a plastic exudation, which is liable to break down and form a large abscess, unless the source of the infection is removed. Abscesses occurring in the later stages are observed at times under the deep cervical fascia, along the course of the internal jugular vein, in the deeper portions of the upper third of the posterior cervical triangle.

Neuroretinitis is noticed in some cases, more especially in the later stages, but it is not a constant symptom.

2. The *general* symptoms are more or less pain in the mastoid region radiating about the side of the head, a chill followed by a sudden rise in temperature to 105°

or 106° F., nausea, vomiting, vertigo, and constipation. In the late stages there is apt to be diarrhœa, which is due to septic poisoning.

Fig. 181.



Temperature-chart of a case of infective thrombosis of the sigmoid sinus, due to acute purulent otitis media.

When a patient suffering from a purulent otitis media, and especially if there are symptoms of mastoid disease, has a sudden chill, followed by a rise in temperature (see Fig. 181), the indications point to the formation of a thrombus, provided a careful examination of the patient's general condition has been made and other diseases can be excluded. There are apt to be marked remissions in the temperature, the latter falling frequently to 99° F., but only to rise again. Rigors occur either early in the disease or may be a late manifestation, and are accompanied by profuse perspiration. The pulse and respiration generally are accelerated during the course of the disease, becoming markedly so during the late stage before a fatal termination. The patient generally retains consciousness to the end, provided there is no meningitis or brain abscess. In only 30 per cent. of uncomplicated cases has loss of consciousness been noted. The tongue usually is coated, and the breath has a disagreeable, fetid odor. When general systemic infection has taken place and the disease progresses unfavorably, certain symptoms predominate, namely, pulmonary, abdominal, or meningeal, according to the organs affected.

In the case of a girl, aged nine years (see Fig. 181), who was admitted to the New York Eye and Ear Infirmary, December 13, 1898, a thrombus, which was partly broken down, was found in the sigmoid sinus eleven days after the first symptoms of acute otitis media developed. Eight days before coming to the hospital she complained of severe pain in the right ear, and was unable to sleep at night. When examined, there were marked redness and swelling of the tissues over the mastoid process, with a decided drooping of the soft parts of the posterior superior wall of the canal. There was bulging of the drumhead, but no perforation. On December 13th the drumhead was incised freely, and the mastoid cells were opened and found to contain pus. The sigmoid sinus was uncovered, so that it could be opened subsequently if further symptoms pointed to thrombosis. As the temperature rose to 106.2° F. two days later, and there had been a high temperature with marked remissions since the operation, it was deemed advisable to operate for sinus thrombosis on December 16th. A free incision was made in the sigmoid sinus and a large thrombus removed. The blood current was re-established from the upper end of the sigmoid sinus, but from the lower end, toward the bulb, the blood flowed but slowly even after a curette had been passed well down to the bulb. Although the lower end of the thrombus contained a drop or two of pus, it seemed better not to prolong the operation by ligating the internal jugular vein on account of the patient's condition, but to wait for twenty-four hours. As the patient was decidedly better on the following day, no further operation was performed. The patient recovered.

The following case in private practice, in which the patient had an acute suppurative otitis media complicated by acute inflammation of the kidneys and sinus thrombosis, seems to be of sufficient interest to mention. When I first saw the patient, a boy, six years of age, I incised both drumheads under chloroform. About ten days previously he had had a streptococcus tonsillitis which he probably caught from the governess who had had the same disease about ten days before his attack, as he slept in her room. Both ears discharged a thick, stringy mucus but the right never discharged as freely as the left ear. There was tenderness over the mastoids at first, but this disappeared and he seemed to be doing well, except that at night the temperature went up at times, and about a week before the operation the temperature rose one evening to 101° F. Nine days after his ears were incised the urine was examined, as his eyes seemed puffy, and a trace of albumin was found with hyaline and granular casts and blood corpuscles. The mastoids were not sensitive on pressure. Three days afterward the urine was pinkish in color, due to more blood in the urine, and albumin and hyaline and granular casts were found. That morning at breakfast time he complained of feeling cold. The temperature ranged during the day from 101.8° F. to 104° F. and the pulse from 104 to 108. Blood counts were made, and on the day of the operation the leucocytes had increased to 25,000. The polymorphonuclears were far in excess of all other cells. After a consultation it was decided to give chloroform and thoroughly examine the ears, opening the mastoid processes if necessary. Chloroform was given during one hour and forty minutes. Both drumheads were freely incised; there was no drooping of the canal walls. The temperature had come down to about 102.5° F.

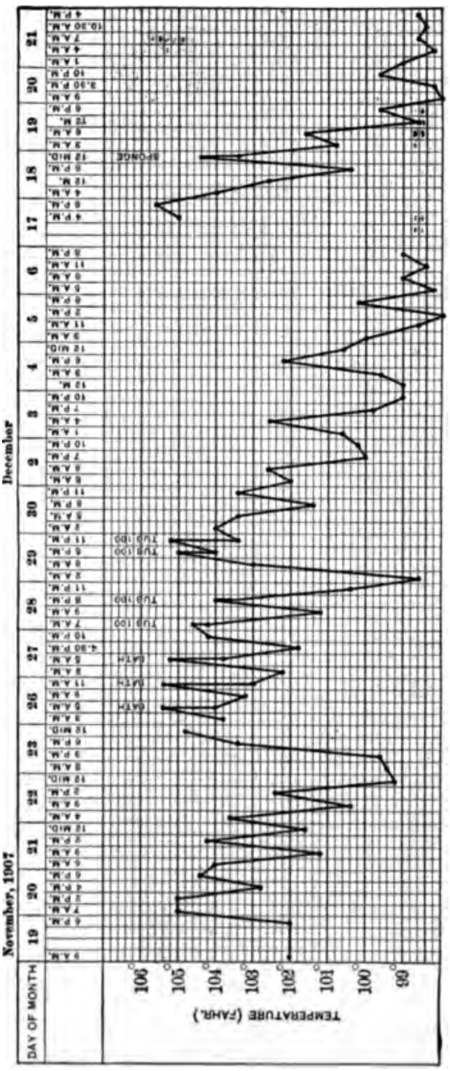
The right mastoid was opened first. The bone was diploëtic with the sigmoid sinus running very close to the antrum and external auditory canal. Softened bone was removed. The outer cortex was very hard. The antrum was opened. The sinus wall was gray and the sinus did not seem to pulsate. It was incised and blood came freely from the upper end but slowly from the bulbar end until a probe was introduced, when it was free.

The left mastoid was opened. The sinus was close to the external wall but not as close as on the right side. The bone was diploëtic. There was softened bone, and more of it on this side, especially about the antrum and toward the middle fossa, the roof of which was opened. The sinus was not opened on that side. Both wounds were packed and the ears bandaged. Saline was given per rectum and the patient was put back to bed in good condition with a pulse of good quality and about 90. The patient did exceedingly well; the kidney condition cleared up and the boy made a good recovery.

Another case was that of a woman, twenty-four years of age, a primipara, who, expecting to be confined in about six weeks' time, came under my care on account of an earache on the left side, resulting from an attack of grippe. For two days she had severe pain and tinnitus, and then the right ear began to ache more severely than the left one. When admitted to the hospital she complained of having been dizzy for the preceding three days, and stated that night before last she had vomited. She had had no chills nor fever. Both drumheads were bulging, with tenderness on pressure over each antrum and mastoid tip. The mastoid symptoms were less marked on the left side than on the right. There was also partial facial paralysis on the right side. The right mastoid process was opened immediately and an examination, under the microscope, of the pus removed from the cells showed marked streptococcus infection. In the left mastoid the disease was even more advanced, having involved the tympanic roof, but when pus from this side was examined microscopically no streptococci were found. Three days later the patient had a severe chill with a sudden rise of temperature to 106.5° F., followed by profuse sweating. There had also been nausea and vomiting before the occurrence of the rigor. A diagnosis was made of sinus thrombosis, and the right sigmoid sinus was opened on account of streptococci having been found in the mastoid cells on this side. A large thrombus was removed, which also showed the presence of streptococci. The blood current was re-established from the upper end, but the blood did not flow from the bulbar extremity. The internal jugular vein was not ligated, as no evidences of the vein having been involved could be detected, and the patient's condition did not seem to warrant further operation at that time. Four days later the temperature was normal. A few days after, she gave birth to an eight months' child. The patient made an excellent recovery and both mother and child were subsequently discharged from the hospital.

That the temperature does not always show marked oscillation is shown in the report of the following case of scarlet fever seen in consultation with Dr. Gruening. A double suppurative otitis media developed as a complication of the scarlet fever and an incision was made in each drumhead. The temperature remained normal for five days. Mastoid disease, however, followed and it was necessary to operate and remove a sequestrum from each side. The child did well for ten days and granulations began to form over each sigmoid sinus wall which had been uncovered, when the temperature suddenly rose to 105° F. It did not oscillate but remained high. There was no pneumonia. The sinus was opened on the side on which the wall was grayish and not as well covered with healthy granulations as

FIG. 182.



Temperature chart of a case of acute purulent otitis media, complicated by pyelitis, and simulating sinus thrombosis.

the other. A septic thrombus was removed and the child recovered.

The following case, presenting some of the symptoms of sinus thrombosis, is an interesting one on account of the difficulties encountered in making a diagnosis: A girl baby, seven months old, on November 19, 1907, had an attack of coryza and sore throat, with a temperature of 105° F. (Fig. 182), followed by an acute otitis media on each side. Both drumheads were incised and three days later the temperature was normal. On the day following, the temperature rose to almost 105° F., and on November 26th reached 105$\frac{2}{5}$° F. The drum membranes were again incised, but in spite of the fact that the ears were discharging, the fever continued until the 29th. On November 29th the temperature was normal, but immediately rose again to 105° F. The fever gradually subsided and the temperature was again normal on December 3d. The baby remained well until December 17th, when the temperature again rose to 105$\frac{3}{5}$° F. The fever gradually subsided and on the 19th was normal. From this time on the patient made an uninterrupted recovery. The urine was repeatedly examined and a blood count made at various times, but the case did not seem to be one calling for an operation on the mastoid antrum and sigmoid sinus, although I was inclined several times to do an exploratory operation. At one time the child had some of the characteristic symptoms of meningitis, such as rigidity of the muscles of the neck, especially when the fever was high. Lumbar puncture was made then, but with a negative result. Finally the diagnosis of *pyelitis* was made, when a large amount of pus was found in the urine, together with a few hyaline and epithelial casts, as well as the bacillus coli communis. This case illustrates the point that a high temperature in a child suffering from an acute suppurative otitis media does not necessarily indicate involvement of the mastoid antrum and sigmoid sinus.

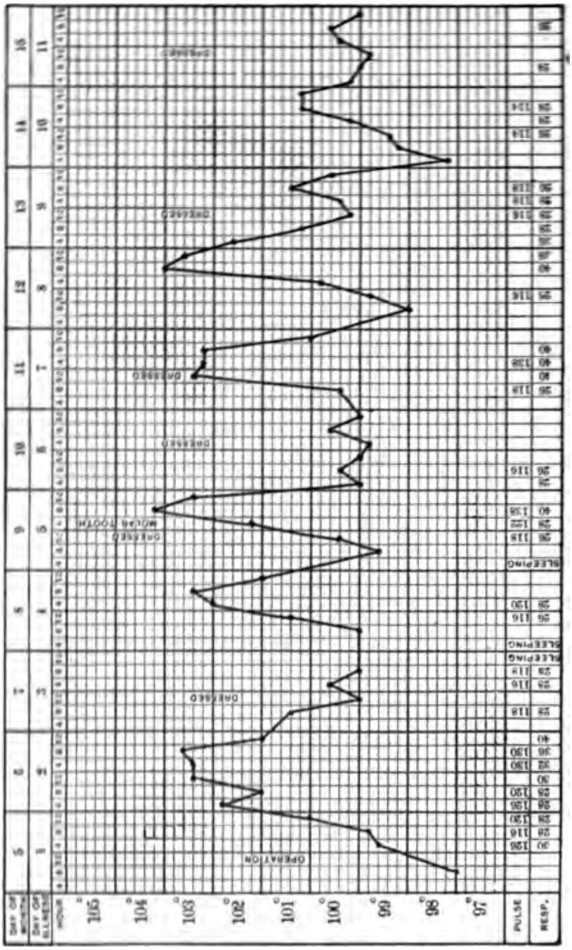
During the past winter the author had under his care two cases of acute mastoiditis in children, both girls, one a year old and the other ten years of age, and in both of these cases pyelitis occurred some time after the operation. In the first case (Fig. 183) this complication developed during the first week following the operation, and occasioned considerable alarm because of the sudden rise of temperature, which suggested an involvement of the sinus. The second case was one of measles, complicated by an acute mastoiditis, but the pyelitis developed some time after the operation.

As to ligation of the jugular vein, Jansen says that "numerous recoveries after incision of the sinus alone certainly go to prove that ligature is frequently unnecessary," and he further believes that one should ligate the jugular only when there is positive evidence of its being involved or where there is pyæmic or septic fever.

When the lungs are implicated, the first symptoms are dyspnœa and cough, with more or less localized pain in the chest. These localized areas of pain are due to infarctions. On examining the chest twenty-four or forty-eight hours later, one will hear moist râles. The sputum is rusty, contains bacteria, and has a very fetid odor. Gangrene of the lung follows, with extensive disintegration. Death in such cases is due to exhaustion. In the abdominal type the disease is likely to be mistaken for typhoid fever. The symptoms are great weakness, loss of appetite, coated and dry tongue, diarrhœa of a fetid character, and delirium. Rigors are infrequent.

The meningeal type is noted less frequently than the

FIG. 183.



A case of acute mastoiditis complicated by pyelitis in a female patient, one year of age.

pulmonary or abdominal, and when present is usually associated with one of the other two forms. Cephalalgia and vomiting are marked symptoms. The meningitis is due to infective thrombosis, or may occur as a complication. Other symptoms are high temperature; agitation; considerable excitement; tonic and clonic contractions of the face, neck, and upper extremities, or paresis; squint; retraction of the head and neck; delirium in the later stages. Rigors are apt to develop when purulent leptomeningitis occurs as a complication. When the leptomeningitis extends to the spine there are, in addition, shooting pains in the spinal region, great prostration, and a sensation of constriction around the waist or girdle pains. The patient gradually passes into a comatose condition, although the mind is clear in the early stages.

Diagnosis. The difficulties in making a diagnosis of sinus thrombosis frequently arise from the complications that are likely to develop, such as meningitis or cerebral abscess, or both. In a simple, uncomplicated case, in which a patient with purulent otitis media has chills, high temperature with remissions, a rapid pulse, vomiting, and in which there is also more or less œdema about the mastoid tip, extending upward and over the exit of the mastoid vein and in the upper third of the posterior cervical triangle, a diagnosis of sinus thrombosis is comparatively certain. The surgeon should not wait for symptoms denoting disintegration of the thrombus and general systemic infection, as the success of the operation depends almost wholly on its early performance. Still, cases do recover in which the operation has been deferred until a late stage, but such instances do not offer much hope.

The blood has been examined by means of cultivations in a considerable number of patients during the past few years for the purpose of determining the presence or absence of bacteræmia in suspected cases of sinus thrombosis. Positive findings have been more or less useful in establishing the diagnosis, particularly in those cases where the clinical symptoms alone have been insufficient, and where other sources of infection could be eliminated. Negative findings, however, are not proof that sinus thrombosis does not exist, for it is possible to have a sterile clot present, for a time at least completely occluding the vessel, which of course could not give rise to a bacteræmia. And there appear to be certain other cases which have proved to have been septic, but which for some unexplained reason did not give positive blood cultures. The following case is interesting in this connection. The case[1] occurred in my service at the Infirmary, and was reported by my assistant, Dr. F. J. Blodgett. The patient had a streptococcus infection of the middle ear, and later it was necessary to perform a mastoid operation. A week later the temperature began to vary from 99° to 102° F., and there was a friction sound heard at the base of the right lung. There was no chill nor vomiting. The blood culture was *negative*. From the clinical symptoms, the patient was undoubtedly septic. The sigmoid sinus was opened and a large septic clot removed, the internal jugular vein and its branches having been first ligated and excised. Five days after excision of the vein the blood culture for the first time was *positive*, and for nearly two weeks there was a septic temperature with wide ranges. When the culture was found to be positive, the patient was given 10 c.c. of the

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[1] Transactions of the American Otological Society, 1911.

Hiss Leucocyte Extract,[1] and this was administered repeatedly. This case was an instructive one, as there was a septic condition due to a sinus thrombosis, while the blood culture was negative. The patient recovered.

Another case, of equal interest, in which the blood culture was positive and with absence of a septic clot in the sigmoid sinus, came under my observation, with the following history: the patient, a young man, had a double acute suppurative otitis media, as a result of scarlet fever. Both drumheads were opened and streptococci were found in the discharge, which was serous and very profuse. He had a sudden rise in temperature to 105° F. There was no tenderness over the mastoid process, but a diagnosis of sinus thrombosis was made because the *blood culture* was found to be *positive*, in spite of the fact that the patient did not have the usual clinical symptoms of sinus thrombosis except the high temperature. The attending surgeon was unwilling to wait, as the bacteriologist had made a diagnosis of thrombosis. He had a virulent catarrh of the nasopharynx, and the point of infection was probably in this region, as neither the mastoid cells nor the sigmoid sinus were found affected. The patient recovered. Sondern,[1] in speaking of scarlet fever, says: "If perchance a streptococcemia exists, which is not unknown in this disease, an erroneous diagnosis of sinus thrombosis would be easily made, if the rule is accepted that a bacteræmia invariably indicates this complication." He further says that "it is important to remember that these general invasions of the blood current may result from local processes other than in the ear, and the mere fact that a bacterial infection of the blood stream is found naturally does not necessarily indicate otitic origin."

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[1] Hiss' leucocyte extract is obtained by injecting aleuronat into the pleural cavities of large, healthy rabbits. The aleuronat is prepared by making a 3 per cent. solution of starch in meat-extract broth, and adding 5 per cent. of powdered aleuronat. It is then thoroughly mixed, boiled for five minutes, poured into sterile tubes, and carefully sterilized. Ten c.c. of the sterile mixture are injected into each pleural cavity, and after twenty-four hours the rabbit is killed with chloroform, the chest opened under aseptic precautions, and the copious and very cellular exudate pipetted off into centrifuge tubes and centrifugalized at once. The supernatant fluid is decanted and 2 c.c. of sterile saline added to each tube.

This emulsion is then thoroughly beaten up with a platinum spatula, examined carefully for contamination before and after incubation, having been diluted in the meantime with twenty volumes of sterile saline.

For greater detail, see Text Book of Bacteriology, Hiss and Zinsser. D. Appleton and Co., 1911.

The clinical symptoms should never be overlooked in making a diagnosis of an intracranial complication, and, to my mind, are much more important than the blood culture. The latter simply acts as an aid in confirming a diagnosis. The blood for cultivation should be drawn directly from a vein, preferably at the bend of the elbow, under strictly aseptic precautions, both to protect the patient from infection and the cultivation from contamination. Not less than 15 c.c. should be drawn, with which suitable culture media can be inoculated, plated, and incubated, and the number of colonies counted. The relation of the number of colonies to the quantity of blood used will indicate the degree of infection, and the appearance and behavior of the growth and its microscopical examination will determine its character. The technique is somewhat complicated, and requires the attention of one familiar with bacteriological methods.

THE TIME TO OPERATE. This is a question that has been much discussed by surgeons, and although opinions differ, the sentiment of the majority is certainly in favor of an immediate operation in case of sinus thrombosis as soon as the surgeon is sure of the diagnosis. Except in rare instances, unless an operation is undertaken to remove a thrombus, a fatal result must be expected. The earlier the operation is performed, the better the chances of success.

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[1] Transactions American Otological Society, June 26, 1911.

Another point in the operation about which different views have been entertained is the advisability of ligating the internal jugular vein. Those opposed to ligation contend that many cases have recovered without tying the vein; that infarctions may be carried into the lungs by the other internal jugular vein; and that, as it is extremely difficult in many cases to find the vein, owing to infiltration of the tissues, the procedure adds greatly to the gravity of the operation. While it is undoubtedly true that minute infective particles may be swept into the circulation in spite of ligation of the internal jugular vein, the general opinion is in favor of tying the vein in all cases in which the sinus contains putrid material, pus, or a disintegrated thrombus, as well as in those cases in which the presence of a thrombus in the internal jugular is evident from the cord-like induration felt along the border of the sterno-mastoid muscle. A thrombus may form in the sigmoid sinus in an incredibly short space of time. I have seen a case in which thrombosis occurred as a result of acute otitis media of only ten days' duration, due to the presence of streptococci. I have also had under my care a boy of eight who developed an acute otitis media as a result of tonsillitis. When called to see him a free incision was made in the drumhead. There were symptoms of mastoid disease at that time. At first there was an improvement, but on the third day the temperature gradually rose to 104.2° F. (rectal), pulse 140. At this time the boy did not complain of pain, but was stupid and inclined to sleep. Under ether an incision was then made behind the auricle, the mastoid cells were exposed from the antrum to the tip, and softened bone with granulations removed. Very little pus was found. The bone was softened, especially in the direction of the jugular bulb, and there was considerable œdema about the mastoid tip and in the direction of the upper third of the posterior cervical triangle. On exposing the sigmoid sinus it appeared to be normal. Temporary improvement followed, but the temperature soon rose again to 104.2° F. (rectal), and two days later, just one week after the beginning of the attack, the boy had a chill lasting about twenty minutes, followed by a temperature of 103.4°, and later 104.4° F. The patient was very drowsy and stupid, and had a rapid pulse. It was decided best to open the sigmoid sinus at once. The sigmoid groove was cut away so that the sinus was exposed for at least an inch and a half. A soft clot was adherent to the walls of the sinus near the bulb, and was removed with a curette. The circulation was re-established at both ends of the sinus, the latter plugged with strips of iodoform gauze, and the wound bandaged. The boy recovered. The case is mentioned to show that, even in patients suffering from acute otitis media, thrombosis of the sigmoid sinus may occur in an incredibly short space of time, and that one should be constantly on the alert for such a complication, especially when the temperature remains high after incision of the drumhead and the presence of streptococci has been demonstrated.

Another case[1] which recently came under observation was a child of four years, who had symptoms of sinus thrombosis, with a temperature of 105° F., due to a mastoid inflammation of both sides. In this patient the infection was caused by pneumococci. The boy had an attack of earache first on one side and later on the other. A free incision was made in each drumhead, and for a short time improvement followed. Both mastoid processes were involved, and it became necessary to remove softened bone and granulations. The temperature immediately fell, and recovery followed. At each operation the sigmoid sinus was exposed, so that, if necessary, a thrombus could be removed if the patient had further symptoms characteristic of such a complication.

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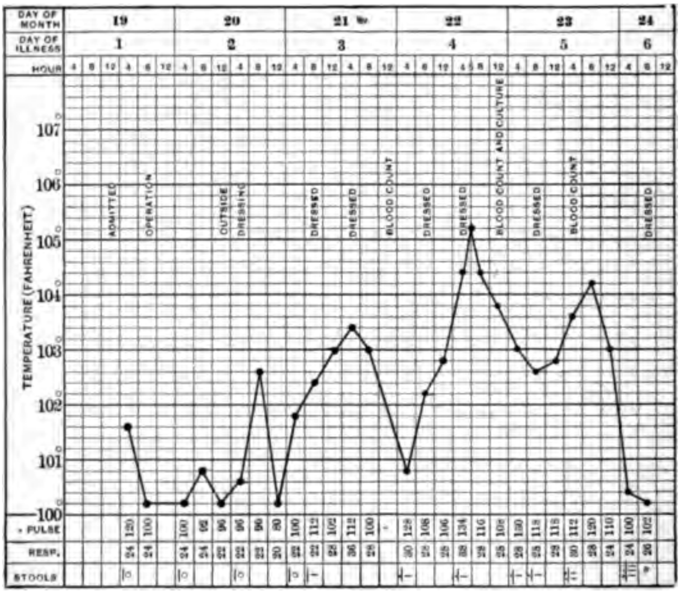
[1] Transactions of the American Otological Society, 1898.

A case seen in consultation with Dr. Gruening had been operated on for double mastoiditis following the grippe—he did well for two weeks, when suddenly he had a temperature of 104° F. following a chill, which fell to below normal, so that within twenty-four hours there was a difference of seven degrees in his temperature. The patient had had chills during the previous summer, and an examination of the blood showed that the rise in temperature was due to malaria, which was cured by the administration of quinine. Sinus thrombosis was naturally suspected.

Erysipelas is occasionally a complication after a mastoid operation, and when it occurs may be mistaken in the early stage for sinus thrombosis. The patient will have a chill, followed by a sudden rise in temperature. I have known of a number of such cases where the sigmoid sinus was opened, and where the fever was due to a latent erysipelas, which did not show the usual blush until twenty-four hours or so after the operation. The following case, in the service of my colleague, Dr. Robert

Lewis, which I saw with him in consultation, is a good example of a case in which the symptoms suggested pneumonia, erysipelas, or sinus thrombosis, and in which the wisdom of waiting is clearly shown (Fig. 184). The patient, a Jewess, eighteen years of age, suffered from a severe cold, and two weeks before admission to the hospital had severe pain in the left ear. A week later her physician incised the drumhead. The pain was relieved at first, but later returned, when she came to the hospital. Dr. Lewis opened the left mastoid process at once and found very extensive disease. Neither the dura nor sinus were exposed. The wound was partially closed

FIG. 184.



A case of acute mastoiditis, followed by erysipelas.

with sutures and packed with iodoform gauze. On the following day the outside dressings were changed, and there was some œdema about the wound. Because of temperature on the next day the clamps were removed from the wound, which was thoroughly cleansed. The wound seemed healthy, the œdema was less, but the patient complained of pain in the ear. On the day following, the œdema about the lower angle of the wound had increased, but the wound was clean. Two days later, or four days after the rise in temperature, a slight blush was noted, extending from the wound to the left upper eyelid, and in two hours' time it had crossed the bridge of the nose and formed several large vesicles. In this condition the patient was transferred to Bellevue Hospital. During the night the temperature had dropped from 104° to 100° F., and the pain in the ear had disappeared.

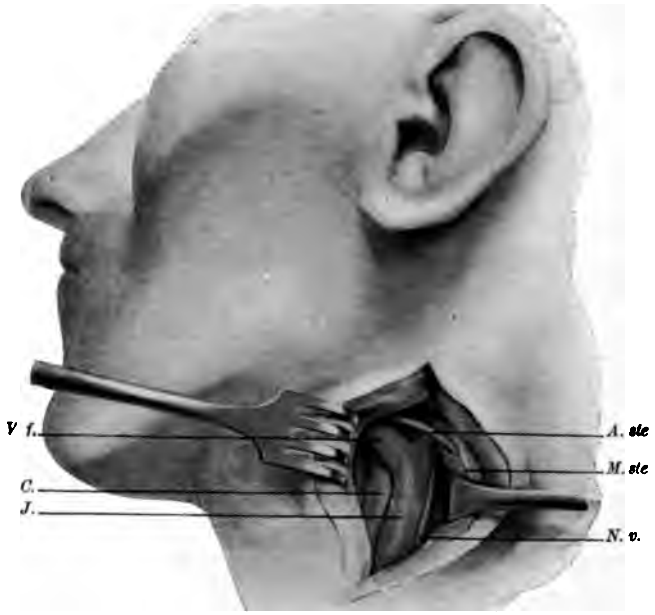
For the treatment of erysipelas, see page 113.

Prognosis. If the diagnosis is made at an early stage, and the operation undertaken at once, the chances of a successful result are fairly good, provided the patient's general condition is satisfactory. When septic poisoning has developed, although there is little hope of a favorable outcome, one should nevertheless remove the source of infection at once.

METHOD OF OPERATION. The first step in the operation consists in making the usual incision behind the auricle for exposing the mastoid cells. The antrum should first be opened freely and its contents thoroughly removed. The tympanic roof should be explored for a carious opening. To uncover the sinus, the surgeon should make a second incision through the soft parts at a right angle to the incision already made for the mastoid operation (see Fig. 147, from the original mastoid incision to point 3), and this should be carried backward so that the flaps can be dissected away from the skull. After having removed all mastoid cells, the sigmoid groove can generally be seen in position. The bridge of bone between the sinus and the antrum should be removed carefully. The sinus in some instances lies very close to the antrum, so that if the latter is opened first and the bone chiselled away layer by layer in a direction directly backward, the anterior knee of the sigmoid sinus will come into view, or if the bone is softened just over the sigmoid groove in the middle portion of the mastoid process, the vessel may be laid bare at that point. (Fig. 187).

The sinus should be exposed to view for at least one inch, in order to give the surgeon an opportunity to determine the existence of a thrombus, and also to enable him to control the hemorrhage, if necessary. The condition of the sinus wall should be noted, whether thickened or covered with granulations. The sinus walls should be thoroughly inspected, while with a probe one should examine to see if a sinus leads to a cerebellar abscess or not. If a large thrombus is present, the sinus will appear unusually prominent, and, by palpation, it will seem firm and dense. The sinus may or may not pulsate. Formerly it was thought that if pulsation was noted there could be no thrombus, but such a view is erroneous. It was formerly the practice among otologists to insert an exploring needle into the sigmoid sinus both upward toward the torcular and also downward toward the bulb. The needle may show the presence of serum, pus, a disintegrated clot, or even blood. The withdrawal of blood does not necessarily indicate the non-existence of a thrombus, because the latter may be very soft (parietal), and there may be a stream of blood running through the centre of the vessel.

FIG. 185.



Ligation of the internal jugular vein (Gerber). ***V. f.*** **Facial vein.** ***C.*** **Carotid Artery.** ***J.*** **Internal jugular vein.** ***A. stc.*** **Sterno-cleido-mastoid artery.** ***M. stc.*** **Sterno-cleido-mastoid muscle.** ***N. v.*** **Vagus nerve.**

If, after exposing the sinus, the surgeon is still in doubt as to the presence of a thrombus, it is much wiser in many instances, provided the patient's condition is satisfactory, to postpone further operative interference for at least twenty-four hours. The only certain method of determining as to the occurrence of thrombosis is to make *a free incision into the sinus wall,* and this should be done in all cases in which the presence of a thrombus is suspected.

If the surgeon determines that there is pus or a disintegrated clot in the sinus, or the thrombus has extended into the upper third of the internal jugular vein, as shown by the presence of a cord-like feeling along the sterno-cleido-mastoïd muscle, he should, before removing the thrombus, make an incision in the integument along the anterior border of the sterno-mastoid muscle, extending from the mastoid tip to the upper border of the clavicle. The internal jugular vein should then be exposed carefully, and after tying both the facial and superior thyroid veins, two ligatures should be applied to the internal jugular vein, one just above the clavicle and the other as near the jugular bulb as possible. The portion of the vein between these two ligatures should then be excised. The greater portion of this wound should be closed by sutures, an opening being left for drainage.

If it has been decided not to ligate at first the internal jugular vein, or the vein has been tied or excised as the surgeon deems best, then an incision should be made in the long axis of the sinus and the thrombus with all obstructions should be removed by means of sharp curettes. One should introduce the curette first toward the torcular and re-establish the current in this direction. By means of a gauze tampon applied directly at this point, and held in position by means of the finger, the walls that have been incised, being folded inward, the hemorrhage can be easily controlled. The curette should then be passed downward toward the bulb, and the current re-established as in the upper portion of the sinus.

If the blood cannot be made to flow, and the surgeon has reason to believe that the clot has extended into the internal jugular vein, he should at once excise the vein, provided the patient's general condition is such as to warrant further operative interference. Reference has already been made to two cases of sinus thrombosis, in which the internal jugular vein was not ligated, owing to the condition of the patients. On the day following the operation there was marked improvement in each instance, and in consequence the sinus was not ligated. If, however, the flow has been re-established, an iodoform gauze tampon should be applied over the sinus at once to control the hemorrhage. The wound should be packed with sterile gauze and then covered with several layers of gauze and cotton before the bandage is applied. The same aseptic precaution should be carried out as in operations for mastoid disease or cerebral abscess. The dressings should not be changed for several days if the patient's general condition shows a decided improvement.

For a number of years I have been in the habit of not ligating or excising the internal jugular vein in cases of thrombosis of the sinus provided the clot was not broken down, and there were no evidences of the vein having become involved, even if the blood did not flow from the bulbar end of the sinus. I have made it a rule to wait for twenty-four hours before tying the vein, with the result that no further operation was necessary in most of the cases. This method of procedure applies particularly to thrombosis following acute mastoiditis. In the operation for signoid sinus thrombosis it is often unnecessary and dangerous to excise the internal jugular vein at the same time, especially in the case of children, for the longer the little patient is under an anæesthetic the more grave becomes the prognosis. The author believes that ligation and excision of the vein add materially to the gravity of the operation and that the condition of the patient should be considered always before resorting to this further operative interference.

Primary Phlebitis of the Jugular Bulb. Considerable attention has been paid of late to a phlebitis and thrombosis occurring primarily in the jugular bulb and especially in the case of children. It is easy to understand how readily the infection may pass through the floor of the tympanum directly to the jugular bulb which lies beneath, particularly if the plate of bone is very thin. The infection is carried by direct absorption, or by means of the small veins and lymphatics. The diagnosis is made usually on account of the following symptoms: a child, for example, has an acute otitis media following, as a rule, streptococcus infection. After the drum membrane has been incised, the temperature, instead of declining as it should under ordinary conditions, suddenly rises to 104° or 105° F., only to fall to normal or below normal. The temperature soon rises again as before, and the child may at times complain of chilly sensations or may only have cold hands or feet before the onset of fever. The pulse is usually rapid. The child generally feels bright and happy when the temperature is low, but when the fever is high the little patient is apt to be dull and listless. According to Jansen papillitis is of common occurrence in cases of primary phlebitis of the jugular bulb. McKernon[1] has reported six cases of primary jugular bulb thrombosis in children with five recoveries. The ages varied from six months to two years, and in each instance the mastoid bone was found normal. The thrombus in each case was removed from above by opening the sigmoid sinus. This is the usual procedure with or without ligation or excision of the internal jugular vein according to the conditions found. Grunert[2] has written a monograph in which he gives the histories of twelve personally observed cases from the Schwartze clinic and five of other authors where the jugular bulb was exposed and opened. The operation, according to this writer, is indicated when, with continuation of severe pyæmic symptoms, the disintegrated thrombus of the jugular bulb cannot be satisfactorily treated by manipulation from the sinus above or the vein below or by irrigation, and in certain forms of primary bulb thrombosis. The operative purpose is to convert the sinus, bulb, and jugular vein into a continuous groove with a common external opening.

For several years, during the winter and early spring in New York, a number of cases of greatly enlarged *cervical glands* have been seen, in connection with acute suppuration of the middle ear, especially in children, and the question has to be decided at once as to the cause of the high temperature. Much alarm is naturally caused by the high fever in such cases, as one is apt to suspect a septic thrombosis. The glands occasionally break down and have to be removed, but as a general rule they resolve, while the temperature will gradually become normal again. The fact must not be lost sight of that sinus thrombosis may exist in some of these cases.

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[1] Transactions of the American Otological Society, 1905.

[2] The Operative Eradication of the Bulb of the Jugular Vein, Archives of Otology, April, 1905.

After an operation on the brain the patient is likely to suffer considerably from shock, so that the pulse becomes weak and rapid. Beside the use of strychnine, digitalis, nitroglycerin, the inhalation of oxygen, and the administration of other remedies, the injection into the rectum of the *normal saline solution* is particularly to be recommended in just such conditions. In extreme cases intravenous injections of the saline solution are necessary.

The Intravenous Injection of the Normal Saline Solution. An excellent solution for intravenous injection is the following one, which is recommended by Hare:

Calcium chloride	0.25
Potassium chloride	0.1
Sodium chloride	9.0
Sterilized water	1000 c. c.

The vein into which the salt solution usually is injected is the median cephalic vein. The patient's arm is uncovered and the skin scrubbed with soap and water, and then washed with a solution of bichloride of mercury (1 : 3000). After a bandage has been applied tightly around the upper arm so as to bring into prominence the median cephalic vein, the skin is dissected away from the vein, and the latter laid bare for the space of an inch or an inch and a half. The surgeon should apply a small bull-dog clip to the proximal end of the exposed vein, in order to keep the lower part of the vein distended with blood. A ligature should then be applied to the distal extremity of the exposed portion and tied. A second ligature should be passed under the vein, but not tied. The surgeon should then divide with a pair of scissors the distended vein between the clip and the ligature which has been tied, and should insert a glass canula into the opening in the vein. The ligature around the vein which was not tied should then be bound around the canula to hold it in position. It is well, before inserting the canula, to immerse it in the saline solution in order to prevent the blood from coagulating on its tip. A piece of rubber tubing, three or four inches long is attached to the exposed end of the canula. By means of a pipette the rubber tubing and glass canula are filled with the saline solution until all the air has been displaced. In order to prevent the introduction of air into the vein, the surgeon should allow the solution to flow first from the irrigator through the rubber tubing connected with it. Then a glass tip, attached to this rubber tubing, is inserted into the other tube. The solution should be allowed to enter the vein very slowly, and the irrigator should not be held higher than three feet above the patient's arm. The amount injected is usually about a quart. A few moments after the solution enters the vein the patient's pulse usually becomes slower and has more volume, while the respirations are less hurried. The fever, if present, is apt to be less. Shortly afterwards, however, the patient may have a severe chill, with a full and rapid pulse. An hour or two later there should be marked improvement in the patient's general condition. Great care should be taken to have the irrigator warm, as well as the saline solution. The temperature of the latter should be 101° F.

In many instances the life of a patient is saved by the timely injection of the normal saline solution, particularly after the operation for sinus thrombosis.

LEPTOMENINGITIS.

There are two varieties of leptomeningitis, the *serous* and the *purulent*, the latter being observed more frequently as a complication of ear disease than the former. Leptomeningitis is a disease which, starting in the arachnoid, may spread very rapidly until the entire subdural and intraventricular spaces are involved, as well as the pia, and at times the superficial portion of the brain. The cerebro-spinal fluid becomes increased in quantity, and the sheaths of the spinal and cerebral nerves often are implicated. This form of inflammation is more serious and fatal than either thrombosis of the sigmoid sinus or cerebral abscess, and is in consequence much more dreaded by the surgeon.

IN SEROUS LEPTOMENINGITIS there is at first a hyperæmia, which is followed by exudation of serum, in which often are found flakes of fibrin and at times a few leucocytes. There may be such a rapid accumulation of serum as to give rise to serious pressure-symptoms, the ventricles becoming greatly distended. At times acute serous leptomeningitis is localized. If a disk of bone is removed from the skull in a patient suffering from this disease, the arteries and veins will be found large and full, and the pia swollen and infected, while clear fluid will be contained within the arachnoid meshwork. After making a trephine opening and reflecting the dura, there may be so much fluid that the meshes of the arachnoid protrude and form a hernia of the membranes, which are filled with fluid.

Purulent Leptomeningitis. In this disease, which may be due to embolism, there is at first hyperæmia with serous exudation, followed by marked dilatation of the veins. The latter at times contain granular coagula. The perivascular spaces also are filled with an exudation of leucocytes. At first the exudation is limited to the arachnoid, as well as the spaces and clefts in the pia mater; but it is liable to extend to the underlying brain substance, which becomes soft and moist, while the ventricles are filled with sero-pus. When the base of the brain becomes involved, the disease is likely to affect the spinal cord.

Symptoms. Headache is usually the first symptom, which may be localized at first, but which eventually extends over the entire head. Other symptoms are restlessness, insomnia, photophobia, hyperæsthesia of the cutaneous nerves, pupils contracted and responding but little to light, abdomen retracted, pulse full, bounding and accelerated, high temperature, and optic neuritis.

Babinski's Sign. Babinski's sign, or reflex, is an important symptom which is elicited when the tendon reflexes are exaggerated. Scratching the sole of the foot causes the patient suddenly to extend the great toe; this is due to a contraction of the extensor muscle. In the normal person, on the other hand, if the sole of the foot be scratched, the toe will be flexed. When the patient has a positive Babinski it is a sign, according to Starr, of some disease in the lateral column of the cord or in the motor tract, and is sometimes observed in cases of leptomeningitis.

Kernig's Sign. In cases of spinal meningitis it has been noticed that if a patient is made to sit up in bed the legs will be drawn up and the knees flexed, and they cannot be extended. In examining a patient to determine whether he has a positive Kernig, the usual method of procedure is to place the patient on his back and then raise his thigh to a right angle or more. In a normal subject this can be done without bending the knee; in one who has a positive Kernig the leg cannot be raised to a right angle without bending the knee. A positive Kernig sign is sometimes present in connection with this disease. In the later stages the patient is dull and stupid, and convulsions, at first confined to the muscles of the face and extremities, become general. The pupils are dilated and often unequal, while the pulse becomes slower, owing to the cerebral pressure. In the last stages paralyses occur, the patient passes feces and urine involuntarily, the respirations are increased in frequency, the pulse is very rapid, the patient becomes comatose, with symptoms of general paralysis, and death follows.

The course of this disease may be extremely rapid, or death may not occur for weeks.

Diagnosis. Symptoms suggestive of meningitis are observed occasionally, more especially in infants which often are due to retention of pus in the middle ear or external auditory canal, so that a diagnosis of this disease is extremely difficult in the early stage. It is only when the spinal fluid is cloudy and under increased pressure, and there are optic neuritis and other characteristic symptoms, that the surgeon can be sure of the diagnosis. This disease is associated occasionally with thrombosis of the sigmoid sinus (see Fig. 186) or cerebral abscess, or with both, so that when these complications occur a diagnosis is extremely difficult.

Lumbar Puncture. Quincke in 1891 was the first to make use of lumbar puncture in a number of cases of hydrocephalus for the purpose of diminishing the intracranial pressure. The procedure consists in inserting a hollow needle into the subarachnoid space and drawing off some of the cerebro-spinal fluid. It is of great value in making a diagnosis of meningitis caused by suppurative otitis media. After lumbar puncture has been made, one may feel reasonably sure of a diagnosis if pus can be demonstrated in the cerebro-spinal fluid by microscopic and clinical examinations, or if the culture is positive. According to Henle[1] "the spaces between the 3rd and 4th, or 4th and 5th, lumbar vertebræ are best adapted for puncture," although some surgeons insert the needle between the last lumbar vertebra and the sacrum. If possible the patient should sit upright and bend forward. The skin should be scrubbed first with green soap and water, and washed with ether. Then a very small incision should be made in the skin. Quincke's method is to introduce the needle a few millimetres to one side of the median line, while Henle enters between the spinous processes and directs the needle upward and inward. The latter uses a canula about 0.6 to 1.2 mm. in diameter and about 5 cm. long (2 inches). There is an advantage in the hollow needle over the trocar in that one can determine immediately whether the dura has been punctured or not. In adults it is safe to introduce the needle to a depth of about 4-6 cm. (1½-2⅜ inches), and in children to a depth of 2-3 cm. (¾-1¼ inches), according to the thickness of the fat and muscles beneath the skin. In order to determine the pressure, a small glass tube should be attached to the needle by means of rubber tubing and then held in a vertical position. In a normal case the pressure varies between 40 and 125 mm. of water. For purposes of diagnosis a few cubic centimetres will suffice, while in cases of meningitis for therapeutic reasons it may be necessary to draw off as much as 100 c.c., although it is better to remove much smaller quantities at each time. The fluid should be drawn off very slowly, as otherwise the patient may complain of weakness. In infants the fontanelle will be depressed if much fluid is removed, so that the surgeon will have that point as a guide in such cases.

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[1] Von Bergmann's System of Practical Surgery.

The routine examination of spinal fluid in the laboratory of the New York Eye and Ear Infirmary requires the determination of globulin, sugar, cell content, and the detection of germs present, if any, by examining the sediment, and by cultures. The Wassermann test is also applied.

The conclusions reached have been that a weak globulin reaction in the case of suspected meningitis is of little value, as a very small amount of blood in the spinal fluid will give the reactions, and it is only when a reaction is marked and out of proportion to the blood known to be present that the test can be used as a point in favor of the diagnosis.

The test for "sugar" has been positive in cases of meningitis and occasionally negative in cases which prove not to be meningeal infection; but it is the rule to have "sugar" disappear in true cases of meningitis.

The Wassermann reaction is generally for record only. The cell count is more reliable, anything over ten cells to the cubic millimeter being regarded as suspicious. In one case of established meningitis the cell count was found to be only 35. On the other hand, in exceptional cases, the cell count may be very high, (microscopical appearance alone indicating pus in the fluid), without grave clinical symptoms, but in these cases cultivations will be negative.

The most important of all is detection of the germ that is responsible for the otitic infection in centrifuged specimens of freshly drawn spinal fluid. Cultures are next in importance, but are second only on account of the chances of an occasional contamination occurring between the spinal canal and the culture media. So that the presence of globulins alone, the absence of copper-reducing substances, or an increased cell content and negative cultures, without well-marked clinical symptoms, cannot be regarded as indicating the onset of meningitis.

Blood cultivations will occasionally show a few colonies in cases of meningitis when signs of sinus thrombosis are absent. The high leucocyte count—say, 20,000 or over, other complications being excluded, will aid in establishing the differential diagnosis between sinus thrombosis and meningitis, but it should be borne in mind that both may be present. In other words, a high leucocyte count is suggestive of meningitis or pneumonia.

Kopetzky,[1] in an interesting paper, published a list of cases in which he found that the normal cerebro-spinal fluid was alkaline or amphoteric, that the fluid continued to be alkaline or amphoteric when obtained from cases which were not acute inflammatory reactions to bacterial activity. On the other hand, all fluids obtained from cases of meningitis and from cases other than meningitis, but exhibiting bulbar symptoms similar to pressure signs, presented the finding of an acidity of varying degree. The writer further says that the presence of a dextrose in the normal spinal fluid has been established as a physiological fact, and that with the onset of acute bacteriological infection of the cerebro-spinal fluid and the central nervous system, examination of fluid withdrawn by lumbar puncture shows an absence of this copper-reducing body. Kopetzky further considers that this test is of great diagnostic value, because it is invariably obtained some time before the presence of microbic organisms have been established in the spinal fluid. This carbohydrate reappears as the bacterial flora disappear from the fluid, and thus the surgeon is enabled to obtain data of value in regard to the prognosis by subsequent examinations of the cerebro-spinal fluid.

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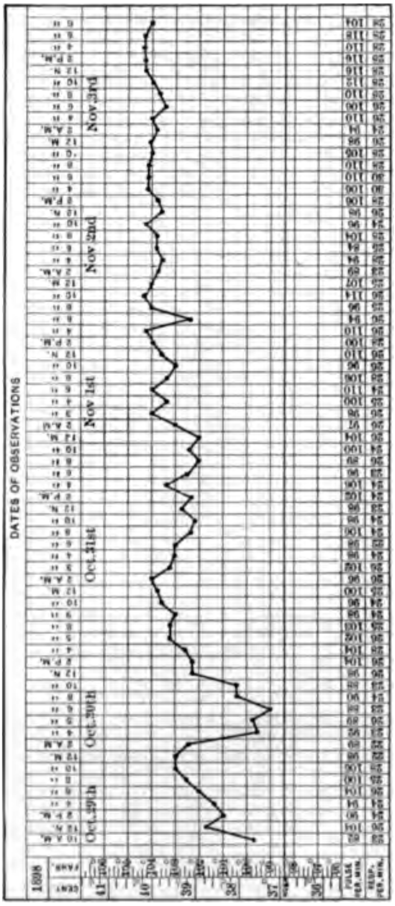
[1] Transactions Ninth International Otological Congress, Boston, Massachusetts, August 12, 1912.

It has been shown by various observers that in normal cerebro-spinal fluid there is a slight trace of choline and Kopetzky goes on to say that "the destruction of the lecithine element in meningitides throws choline into the spinal fluid, and this base is carried from the fluid into the venous blood and thus produces its systemic effects. The presence of an appreciable amount of albumin and of an access of globulin is also of diagnostic importance."

In addition to the examination of the spinal fluid, the blood pressure should be constantly estimated, and the fundus of the eye should be watched for increased tension of the veins and for swelling of the papilla. If these views advanced by Kopetzky prove to be correct, it will be possible to make a diagnosis of meningitis at an earlier stage of the disease, and thus afford the surgeon a better chance of effecting a cure, by operative interference, in what are now considered to be almost hopeless cases.

FIG. 186.



Temperature-chart of a fatal case of chronic suppurative otitis media followed by sinus thrombosis and suppurative leptomeningitis.

Prognosis. Although this disease is generally fatal, the prognosis is not necessarily hopeless, for cases have recovered, especially after operation. The view entertained by most otologists at the present time, however, is that only cases of localized meningitis recover, and that when the disease is diffused the result is usually fatal. Dr. Day,[1] of Pittsburg, has recently reported fifty-seven cases of meningitis of otitic origin with three recoveries, which were under his care, and he believes that these three cases had a localized meningitis.

Treatment. As infective meningitis occurring in this connection is usually due to an extension of the disease from the middle ear or mastoid cells to the meninges, it is important first of all to open the antrum and explore the tympanic roof when there are symptoms of infective meningitis of the middle cranial fossa, and to remove all purulent secretion between the bone and the dura or pia mater. If the symptoms point to involvement of the base of the brain and spinal cord, the thin plate of bone covering the sigmoid sinus should be cut away and the posterior cranial fossa investigated. In cases of serous meningitis, after exposing the dura the surgeon should make an incision in it so as to cut into the subarachnoid space, in order to drain as thoroughly as possible the copious serous fluid, and thus relieve the pressure symptoms. Lumbar puncture should also be done.

Some difference of opinion exists among surgeons as to the propriety of opening the dura in cases of purulent meningitis. Some are opposed to any operation while others feel that the only hope of saving the patient lies in making a free incision through the dura and in resorting to lumbar puncture.

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[1] Paper read at the Congress of Clinical Surgeons of North America, November 11, 1912.

If a diffuse suppurative meningitis exists, the patient is almost sure to die so that we are justified in operating in such cases, for in a number of instances recovery has followed operative interference. Macewen has reported several cases of purulent lepto-meningitis followed by recovery, in which he found the tympanic roof eroded, the dura congested and covered with pus. A free incision was made in the inflamed membranes, which permitted the purulent intradural exudation to escape. In these cases the area of the infective process was undoubtedly limited, for when there is general implication of the membranes the case is usually, but not always fatal.

It is always well in doubtful cases in which the symptoms are grave and point to intracranial involvement, to make a thorough investigation of the antrum and tympanic roof, as well as of the sigmoid sinus. Then, if there are well-marked clinical symptoms and we find bacteria in the fluid drawn off by lumbar puncture, the surgeon should remove thoroughly all diseased bone in the mastoid cells and expose the dura. A crucial incision, of the size of a half-dollar, should then be made in the latter so as to penetrate beneath the subarachnoid space. Sometimes it is necessary to tap the lateral ventricle. In this, as in all other operations, the most thorough antiseptic precautions should be followed, and it is wise to do but little syringing for fear of spreading the infection. The normal salt solution should be used. Lumbar puncture should be practised systematically and repeated as a means of diagnosis and treatment. About 15 c.c. should be withdrawn at a time.

B. A. Randall has reported good results in cases of commencing meningitis by washing out the subdural space with an antiseptic solution.

Haynes[1] has described a new operation, and has reported a few cases of meningitis in which he drained the cisterna magna. He says that "this space is in free communication with all the other subarachnoid spaces about the brain and cord, and also through the foramen of Magendie with the ventricles of the brain. Physiology teaches us that the cerebro-spinal fluid is secreted by the choroid plexuses of the ventricles, and flows from them into the great cistern before taking its final course over the convexity of the brain to enter the sinuses by way of the Pacchionian bodies." Thus far this operation has not proved to be any more successful than the usual decompression operation which has been described.

Packard,[2] of Philadelphia, has reported a case of acute mastoiditis with influenzal meningitis, in which he believes that recovery was due to intraspinal injections of anti-influenzal serum.

Serum therapy is of great value in cases of epidemic cerebro-spinal meningitis due to the meningococcus, and Flexner,[3] in a paper on this subject, reported 1295 serum-treated cases of proven epidemic meningitis, of which 70 per cent. recovered. His conclusions were, that "the antimeningitis serum (Flexner's), when used by the subdural method of injection, is capable of reducing the period of illness, of presenting in large measure the chronic lesions and types of the infection, of bringing about complete restoration of health in all but a very small number of the recovered, and of greatly diminishing the fatalities due to the disease." The serum treatment of otitic meningitis has been followed by little, if any, success, although some surgeons have reported cases of recovery in which a large quantity of fluid had been withdrawn from the spinal canal by lumbar puncture, followed by the injection into the canal of antistreptococcic serum.

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[1] Transactions Ninth International Otological Society, Boston, Massachusetts, August 12, 1912.

[2] Transactions of the American Otological Society, 1916.

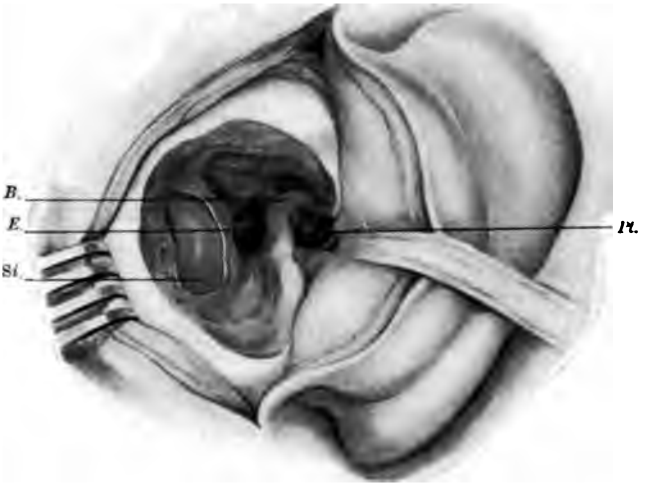
[3] The Edinburgh Medical Journal, May, 1912.

McKernon and Haskin, of New York, have reported successful cases in which they removed a large quantity of cerebro-spinal fluid by lumbar puncture, and immediately injected into the cord 40 to 60 grains of urotropin in normal salt solution. The Hiss Leucocyte Extract has also been used with success by others. In the serum, as well as in the surgical treatment of otitic meningitis, an early diagnosis is most important.

SUPPURATIVE INFLAMMATION OF THE LABYRINTH.

According to Jansen 62 per cent., and according to Whitehead 36 per cent. of cases of labyrinth suppuration succumb to meningitis. For some years operations have been performed in cases of suppuration and necrosis of the labyrinth. Jansen was the first to open the vestibule and semicircular canals, followed by Stacke, Kœrner, Lannois, Lermoyez, Ballance, Neumann, Alexander, and many others, and, according to these authors, operations on the labyrinth, although dangerous, are justifiable. In extensive necrosis of the labyrinth there is apt to be paralysis of the facial nerve. Dundas Grant says: "After the mastoid operation, the persistence or the reappearance of cephalalgia, fever, vertigo, vomiting, and nystagmus should make us consider the possibility of suppuration of the labyrinth, symptoms similar to cerebellar abscess, but much more frequently they are labyrinthine." He further believes that in addition to the radical operation, cases of serous meningitis should be treated by lumbar puncture and opening of the labyrinth, and in cases of cerebellar abscess without sinus phlebitis, the labyrinth should be opened and carefully inspected.

FIG. 187

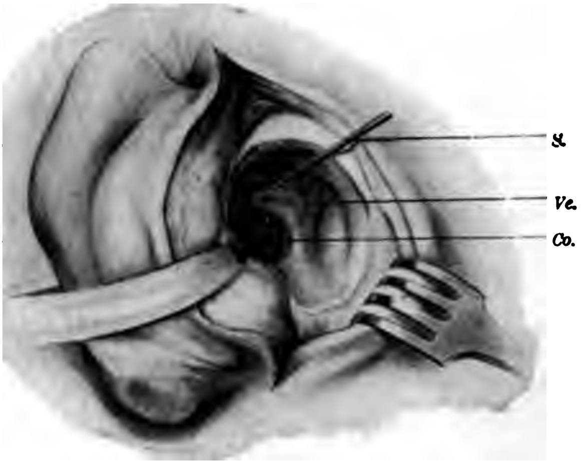


Removal of mastoid cells showing sinus exposed (Gerber). *B.* Horizontal semi-circular canal wall. *Si.* Sigmoid sinus. *Pt.* Promontory. *E.* Point sometimes selected for exploring the cerebellum for abscess.

Ballance has removed the semicircular canal in a suppurative case, in which the principal symptom was extreme vertigo, with deafness and persistent noises so that the patient could not cross the room. After the operation the noises and vertigo disappeared, and the hearing was slightly improved.

Anatomy and Physiology.—While the anatomy of the internal ear has been described in a previous chapter, it is necessary to discuss more fully certain points in the anatomy of the vestibule and semicircular canals, which have a direct bearing on the characteristic symptoms of inflammation of the labyrinth.

FIG. 188.



Opening of the labyrinth. Posterior and horizontal semicircular canals opened (Gerber). *S.* Sound introduced into the horizontal canal and brought out in the foramen ovale. *Ve.* Posterior semicircular canal. *Co.* Opening into cochlea after removal of the promontory.

The semicircular canals are three in number, and open into the vestibule.

1. External or horizontal semicircular canal.
2. Anterior vertical, or superior semicircular canal.
3. Posterior vertical, or posterior semicircular canal.

They are situated in three planes of space at right angles to each other.

The external canal is not exactly horizontal, but is inclined somewhat backward and downward. To place it in the horizontal position the head must be inclined 30 degrees forward. Each canal comprises two-thirds of the circumference of a circle and is expanded at one of its ends where it enters the vestibule. The ampulla of the external canal lies at its anterior end and that of the superior canal is situated at its outer extremity. The ampulla of the posterior canal is situated at the lower extremity, while the upper end of the posterior canal and the posterior end of the superior canal unite to form a common passageway before their entrance into the vestibule. The ampullæ contain the end-organs of the vestibular nerve.

The vestibule is situated behind the cochlea and in front of the semicircular canals, and lies to the inner side of the aditus and middle-ear cavity. It is a chamber of irregular shape into which the semicircular canals open.

Through the fibres of the vestibular nerve (the vestibular division of the 8th) the membranous labyrinths are intimately connected with various centres in the medulla, pons, cerebellum and cerebrum. After the fibres from the vertical canals (superior and posterior) enter the brain, their course is distinct from that of the horizontal canal.

While all of these tracts have not been microscopically demonstrated, there is good reason for believing that their course is as follows: The nerve pathway of the horizontal canal is assumed to be over the vestibular nerve to Deiters's nucleus in the upper portion of the medulla, where it divides into two tracts: (1) *The vestibulo-ocular tract, or Deiters's oculomotor tract,* concerned in the production of nystagmus. The fibres pass from Deiters's nucleus through the posterior longitudinal bundle (posterior longitudinal fasciculus) to the nuclei of the 3rd, 4th and 6th nerves supplying the eye muscles. (2) *The vestibulo-cerebello-cerebral tract,* responsible for vertigo. From Deiters's nucleus this tract enters the cerebellum through the inferior cerebellar peduncle to the three vestibular cerebellar nuclei of the same side, from which it proceeds upward through the superior cerebellar peduncle and continues to the cerebral cortex on both sides, but more especially the opposite side through the crura cerebri and internal capsule. The cortical areas which receive these fibres are supposed to be in the posterior part of the second temporal convolution (Mills), adjacent to the cortical area for hearing.

The pathways for the vertical canals are assumed to be over the vestibular fibres of the 8th nerve to the upper portion of the medulla, ascending thence in the pons to a point opposite the middle cerebellar peduncle, where they divide into two portions. (1) In the nystagmic or vestibulo-ocular tract the fibres enter the posterior longitudinal bundle through which they pass to the eye muscle nuclei of the 3rd, 4th and 6th nerves. (2) The vestibulo-cerebello-cerebral tract reaches the cerebellum through the middle cerebellar peduncle, entering the cerebellar nuclei of the same side, from which it proceeds upward through the superior cerebellar peduncle and continues to the cerebral cortex on both sides, more particularly to the opposite side through the crura cerebri and the internal capsule. The end-organs (crista ampullaris) in the semicircular canals respond to rotation of the body, and acquaint us with the speed and direction of rotation so as to help our equilibrium. The function of the end-organs in the saccule and utricle is less known, but they are supposed to have to do with orienting the body in space and with the perception of motion in a straight line.

The Static Labyrinths. The static labyrinths are the essential organs of equilibration and are of extreme importance to the individual for the determination of his position in space. When the function of these organs is destroyed, as in deaf-mutes (or a person suffering from a bilateral labyrinthitis), it is partially compensated for by the visual, muscle and arthrodial senses. Not wholly, however, for the equilibration of an individual thus affected is never perfect, and when suddenly placed in an unusual position disaster occurs. Practical examples of this are seen in deaf-mutes who are unable to swim under water or who are liable to giddiness when looking from a tall building. When one labyrinth only is destroyed its function is soon compensated for to a greater or less degree by the brain centres and the remaining labyrinth.

It has been found that movements in the endolymph of the semicircular canals cause certain definite movements of the eyes.

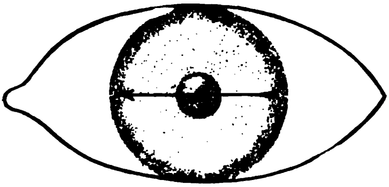
The peculiar phenomena which are associated with stimulation or disease of the labyrinth are:

1. Nystagmus.
2. Vertigo.
3. Nausea and vomiting.
4. Disturbance of equilibrium.

Nystagmus is an associated rhythmic to-and-fro movement of both eyeballs. There are various kinds of nystagmus, ocular, hysterical, etc., but vestibular or labyrinthine nystagmus has certain definite characteristics. It is composed of two elements or components: A slow movement in one direction, vestibular in origin, and a quick movement, a return of the eye to its original position, the latter being of purely cerebral origin. The direction of the nystagmus has been named according to the direction of the quick component. This is perhaps unfortunate, for the vestibular component is the important element in nystagmus. Vestibular nystagmus is intensified by turning the eyes in the direction of the quick component and is lessened by turning them in the opposite direction. By spontaneous nystagmus we mean that observed in the patient without the aid of artificial stimulation. By induced nystagmus we mean that caused by artificial labyrinthine stimulation, *i. e.*, by the caloric, rotation or galvanic tests. Nystagmus is also horizontal, rotatory or vertical. In horizontal nystagmus the eyeball rotates on a vertical axis in a horizontal plane; in rotatory nystagmus on a horizontal axis and in a frontal plane.

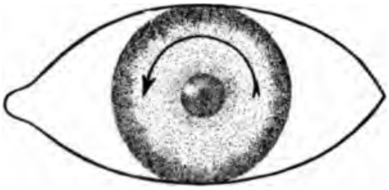
The direction of rotatory nystagmus is determined by the direction of the upper end of the vertical meridian of the eyeball. In vertical nystagmus the eye rotates in an antero-posterior plane. There may be also various combinations of the two, varying from pure horizontal to pure rotatory or pin-wheel nystagmus. The direction of vestibular nystagmus always

Fig. 189.



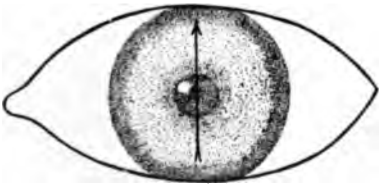
Horizontal nystagmus.

Fig. 190.



Rotatory nystagmus.

Fig. 191.



Vertical nystagmus.

bears a direct relation to the direction of the vertigo and falling, if these are present. Each canal when stimulated produces a nystagmus and a vertigo in its own plane. The eyes are always drawn in the direction of the endolymph movement. (This is the slow component of the nystagmus.) The vertigo is always in the direction opposite to the endolymph movement.

Ewald[1] has proved by experiment on pigeons that in the horizontal semicircular canal greater stimulation results when the endolymph flows toward the ampullæ than when in the opposite direction, and that in the vertical canals, greater stimulation results when the endolymph flows away from the ampullæ.

It is supposed that stimuli are constantly passing from each labyrinth to the brain, creating a state of balance. If anything disturbs this balance, such as excessive stimuli from one labyrinth or a decrease in stimuli from another (*i. e.*, destruction of a labyrinth) this balance is upset and the labyrinthine phenomena may be observed, *i. e.*, nystagmus, vertigo, nausea and vomiting and disturbance in equilibrium.

If one labyrinth is totally destroyed the state of "imbalance" thus created gradually disappears. This is due to the fact that the individual gradually gets used to impulses passing from one labyrinth only.

Labyrinthine Vertigo.—Vertigo bears a direct relation to the direction of the nystagmus and is always in a direction opposite to the endolymph movement, that is, in the direction of the quick component of the nystagmus.

Examination of the Labyrinth.—Examination of the acoustic (cochlea) as well as the static (vestibule and semicircular canals) labyrinth is important in the diagnosis of labyrinthine disease. In order to test the hearing of one ear separately a noise apparatus is necessary. This is a clockwork machine (Fig. 192) with an ear-piece, which when placed in the ear and started makes such a noise as to entirely take up the hearing of that ear, leaving the other free to be tested by the examiner. If a loud voice can be heard in the free ear we can be sure the cochlea has not been affected by a suppurative process. If a loud, shouting voice cannot be heard close to the ear we assume, with a fair degree of certainty, that the patient is totally deaf in that ear. Total deafness in the presence of a suppurating ear is fair presumptive evidence that the cochlea has at one time been invaded by the suppurative process. Tuning-forks should also be used, *i. e.*, if the Weber test is lateralized to the sound side and the Rinné is negative, the diagnosis of total deafness is further substantiated.

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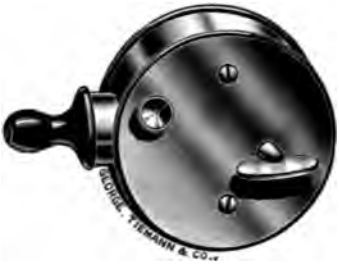
[1] Ewald's Experiments.

FIG. 192.



Bárány noise apparatus.

Examination of the Static Labyrinth.[1]—Only recently has come the realization that the static labyrinth is but a part of the vestibular apparatus and that this vestibular apparatus consists not only of the static labyrinth itself but also of the nerve paths connecting with nerve centres in the brain stem, cerebellum and cerebrum.

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[1] From the excellent article of Jones and Fisher, Technic of Examination of Static Labyrinth, Annals of Otology, xxvi, No. 1.

"When a known stimulus is applied to the labyrinth any response therefrom, be it nystagmus or vertigo, indicates not only a functionating and reacting labyrinth but also intact pathways from the labyrinth to the brain centres responsible for these reactions. Conversely, the non-appearance of any of the normal responses to stimulation indicates an interruption at some point along the particular pathway that fails to produce that particular response."

It has been recently demonstrated by Randall, Jones and Fisher, of Philadelphia, that the fibres from the so-called horizontal canal have an entirely different course in the brain stem from those of the vertical semicircular canals. They all go to the cerebellum, but those from the horizontal canal reach it by way of the inferior peduncle, while those from the vertical canals go by way of the middle cerebellar peduncle. They are further convinced that nystagmus and vertigo are distinct and separate phenomena and that the "past pointing" (a test to be alluded to later) is not, in the words of its originator, Bárány, "a cerebellar pull," but is cerebral exclusively and depends entirely on the vertigo induced by the ear stimulation.

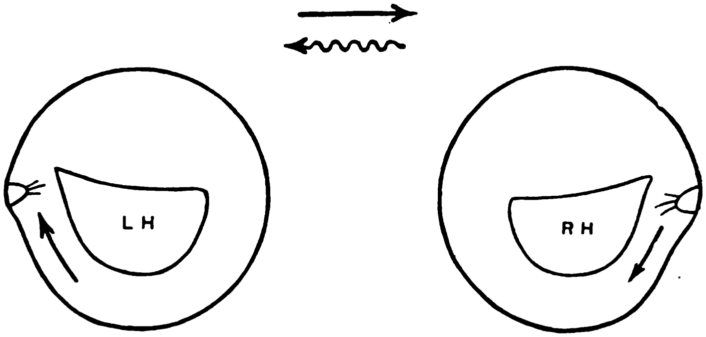
This subject is of growing importance and furnishes another bond between the neurologist and the aural surgeon. While all of these tests are not necessary to establish the integrity of the labyrinth itself, it has seemed advisable to place them before the student in detail, and while the deductions to be drawn from them may be subject to future change or correction, nevertheless their present value in the diagnosis of lesions in the region of the cerebellum, pons and medulla make them worthy of serious consideration.

The Caloric Test By this test we can stimulate either labyrinth separately, and by changing the position of the head analyze the function of the canals separately. When the head is in the upright position, and the ear is douched with water of a temperature of 68° F., a nystagmus will be set up to the opposite side; if water of 112° F. is used a nystagmus occurs toward the same side. We rarely use the hot water, as it causes severe discomfort to the patient. With the head inclined 30 degrees forward the vertical canals alone are stimulated. To test the horizontal canals the head is inclined 60 degrees backward. This reaction is produced by an endolymph movement set up by the cold applied to the auditory canal, the chilling setting up a current in the downward direction. This reaction normally occurs after douching the ear for from one-half to one minute and usually lasts for from thirty to sixty seconds. If douching is persisted in after the first appearance of nystagmus the reaction is often attended by nausea, vomiting, vertigo and disturbance of equilibrium. An absence of the caloric reaction usually means a non-functionating labyrinth, but anything that prevents chilling of the endolymph may prevent or delay the reaction, such as stenosis of the external auditory canal, granulations in the canal or cholesteatoma.

A normal reaction means a functionating labyrinth on that side.

The Rotation Test. This test depends on the fact that if an individual be rotated on the vertical axis of his body he will exhibit certain reflex movements of the eyes (nystagmus), which are due to certain endolymph movements set up in the semicircular canals. In practice this is done by rotating the patient in a specially designed revolving chair (Jones chair) (Fig. 199). He is rotated with the eyes closed ten times in twenty seconds, then told to open his eyes, and the duration of the nystagmus is noted. The normal duration is about twenty-six seconds. Certain facts about the rotation test should be remembered by the student. (1) The labyrinths of both sides are stimulated simultaneously. (2) Only such canals as lie in the horizontal plane at the time of the rotation are stimulated. (3) To stimulate the horizontal canals alone the head should

FIG. 193.

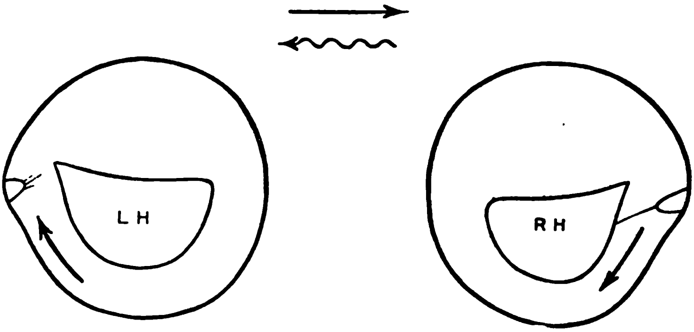


Diagrammatic cross-section of vestibules and horizontal semicircular canals. Straight arrow represents direction of rotation; wavy arrow represents direction of nystagmus after rotation. Arrow in semicircular canal indicates direction of endolymph current. The left canal is seen to receive the greatest stimulation because in this the endolymph is flowing toward the ampulla. The right canal receives but little stimulation because in it the endolymph is flowing away from the ampulla. (Modified after Braun and Friesner.)

be inclined forward 30 degrees. This is the usual test employed. (4) To test the vertical canals, the head during rotation should be inclined either 60 degrees backward or 120 degrees forward. This position will place the horizontal canal in the vertical plane where it is not affected by rotation.

Let us assume that a patient is seated in the rotation chair with head inclined 30 degrees forward and rotated ten times to the right in twenty seconds. During the first few turns, owing to the inertia of the endolymph, an endolymph current will be set up to the left. This will cause a nystagmus to the right. As the rotation continues the inertia of the endolymph is overcome and an endolymph current is set up to the right. When the rotation is stopped, the momentum of the endolymph causes its movement still to the right, setting up a *nystagmus now* to the left. This is called

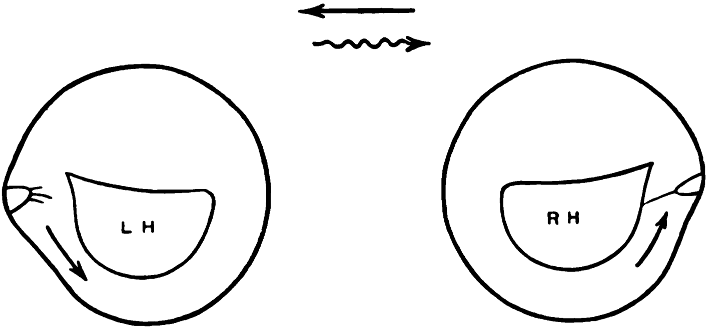
FIG. 194.



The right labyrinth is seen to be non-functionating. On rotation to the right the left intact labyrinth received the greatest stimulation, because the endolymph current is flowing toward the ampulla, consequently nystagmus is about of normal duration. The non-functionating labyrinth (right) receives little if any stimulation (endolymph flowing away from the ampulla).

the nystagmus after rotation or the after-nystagmus. The nystagmus set up during rotation is hard to observe and for practical purposes may be disregarded. It is the *after-nystagmus* that is important. As the endolymph in both horizontal canals has the same direction, stimuli from one canal will reinforce the other. The patient may be then rotated to the left ten times and an after-nystagmus to the right will be set up. The rotation test is used to compare the two labyrinths. We can do this because of the fact that in the external canals stimulation caused by the endolymph flowing toward the ampullæ is greater than that caused by the endolymph flowing away from the ampullæ, and in the vertical canals stimulation is greater when the current is away from the ampullæ.

Fig. 195.



Right labyrinth non-functionating. Rotation to the left. The right labyrinth now received the greatest stimulation because the endolymph flows toward the ampulla. This stimulation is ineffective, however, as the labyrinth is non-functionating. The nystagmus is of short duration as it is caused by the left labyrinth alone, which receives but little stimulation (endolymph flowing away from the ampulla).

Let us suppose that the right labyrinth is non-functionating.

Rotation to the right causes nystagmus to the left of about normal duration because the functionating labyrinth, the left, is stimulated the greatest (Fig. 194). Rotation to the left (Fig. 195) causes a nystagmus to the right of very short duration (sometimes it is entirely absent), because the non-functionating labyrinth receives the greatest stimulation and the left labyrinth comparatively little. Therefore it is seen that rotation to the right causes nystagmus to the left and rotation to the left causes nystagmus to the right. The labyrinth on the side opposite to the direction of the rotation receives the greater stimulation.

A marked difference in the duration of the after-nystagmus upon rotation to the right and to the left indicates that the labyrinth is non-functionating. This difference must be more than double to be of diagnostic value. In the presence of spontaneous nystagmus the interpretation of the rotation test becomes very complicated. With the head inclined 120 degrees forward or 60 degrees backward, the vertical canals are thrown into the horizontal plane and may be tested. On account of their position to each other it is impossible to test the right anterior vertical and the left anterior vertical at the same time, but by inclining the head forward 120 degrees and then rotating it to the right 45 degrees the right anterior vertical canal and the left posterior vertical may be placed in the same horizontal plane and thus tested together. *Vice versa,* inclining the head forward 120 degrees and rotating the head to the left 45 degrees will bring the left anterior vertical and the right posterior vertical canal into the same horizontal plane.

With the head 60 degrees backward, rotation to the right sets up a rotatory after-nystagmus to the right and, *vice versa,* rotation to the left sets up a rotatory after-nystagmus to the left.

With the head inclined forward rotation to the right sets up nystagmus to the left, and rotation to the left sets up a nystagmus to the right.

The Fistula Test. This test produces a nystagmus by a rarefaction or a condensation of air in the external auditory canal. It may be performed with a Politzer bag and a nose-piece or a Siegle's otoscope. Instead of nystagmus, slow movement of the eye only may be present.

A fistula test can only be positive when there is an active labyrinth. When present it denotes a defect in the bony labyrinthine capsule and that the labyrinth is active. A negative fistula test does not exclude a fistula. The careless and undue use of the fistula test may convert a perilabyrinthitis into a diffuse condition, and it should therefore be used with extreme caution.

Etiology.—Suppuration of the labyrinth is generally due to extension of the disease from the middle ear through its inner wall, either through the foramen ovale or rotundum, the promontory, or the external semicircular canal. The infection may, however, travel from an extradural abscess, from infection about the base of the brain, which can be transmitted along the perivascular sheath of the internal auditory artery and the perineural sheaths of the facial and internal auditory nerves. The infection may be carried through the aqueductus cochleæ from the subarachnoid spaces. Labyrinthine suppuration is almost always due to chronic purulent otitis media, rarely to the acute variety. It is often due to tuberculosis or the presence of a cholesteatoma in the tympanum. Other causes are fracture of the base of the skull, paracentesis of the membrana tympani, clumsy and unskilful operations on the middle ear, especially the performance of the radical mastoid operation, when, by too thorough curetting, it is possible to carry the infection through the inner wall of the tympanic cavity. Cerebro-spinal meningitis is also a cause of labyrinthitis, as well as scarlatinal otitis media.

Pathology.—There may be increase of fluid in the endolymphatic as well as in the perilymphatic spaces. There may be proliferation or destruction of bone, the latter occurring by necrosis or rarefying osteitis. If recovery does not take place, meningitis follows, the infection being carried to the meninges by means of the internal auditory meatus, the aqueductus cochleæ or aqueductus vestibuli. According to Görke osteitis of the capsule is a sequel of necrosis, and meningitis may result from any portion of the petrous bone.

Suppuration of the labyrinth may be acute or chronic, and in either form the inflammation may be diffused or circumscribed. The inflammation is more likely to be circumscribed if the infection has invaded the external semicircular canal from the middle ear, while it is apt to be diffused if the organisms gain entrance to the vestibule through the foramen ovale or rotundum. There may be a paralabyrinthitis, a perilabyrinthitis, or an endolabyrinthitis. At first the membranous labyrinth becomes opaque and deeply congested, and the inflammation extends to the endosteum and the bone itself. The lining epithelium undergoes degeneration, and lymphocytes and leucocytes are found in the perilymph and endolymph. If the pus cannot escape, necrosis is likely to follow, and large sequestra are removed frequently from a localized suppuration.

Symptoms.—Labyrinthitis following middle-ear suppuration may be classified clinically as follows:

1. Acute diffuse labyrinthitis.[1]
2. Chronic diffuse labyrinthitis.
3. Paralabyrinthitis: (*a*) with fistula, (*b*) without demonstrable fistula.

1. *Acute diffuse labyrinthitis* follows either an acute or a chronic middle-ear suppuration, usually a chronic condition. Its onset is sudden and is characterized by severe vertigo with nausea and vomiting, nystagmus and disturbances of equilibrium.

The nystagmus is usually rotatory and at the onset is directed toward the diseased side. In a few hours, however, when the function of the end-organ is destroyed, the direction of the nystagmus changes and is toward the sound side. Nystagmus toward the diseased side is of such short duration that it is rarely observed by the physician. This nystagmus is seen in all positions of the eyeball and is accentuated when the patient looks in the direction of the quick component. It is less when the patient looks in the direction of the slow component. The more rapid the invasion of the labyrinth, the more severe are the symptoms. The patient usually lies on his sound side, for in this position the vertigo is less. The vertigo is intense and at the height of the attack any slight movement of the head may bring on severe attacks of nausea and vomiting.

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[1] Ray, Annals of Otology, vol. xxvi, No. 1.

The patient is unable to walk, but if placed on his feet will show a tendency to fall in the slow component of his nystagmus.

At the onset of the attack the deafness is of middle-ear character, *i. e.*, the patient is deaf for low notes, hears high notes, has increased bone conduction, negative Rinné, and Weber to the diseased side. Soon destruction of the cochlea changes this and the patient is seen to be totally deaf when the noise apparatus is used.

During an acute attack the patient should never be subjected to the caloric or rotation tests. In a few days the acute symptoms subside.

If the attack has been serous in character, recovery may take place without, at any time, complete loss of hearing and without the phenomena which may be attributed to complete destruction of the end-organ, *i. e.* (nystagmus of the sound side, etc.). With subsidence of the inflammation, the ear may revert more or less to its previous condition (with more or less hearing and a functionating vestibular apparatus). At the onset serous and purulent conditions cannot be differentiated, but rapid progress and early destruction of the end-organ indicate a purulent condition. Thus it is seen the necessity for frequent hearing tests in acute labyrinthitis.

In the purulent conditions, endocranial complications may ensue or the case gradually pass into a chronic condition.

2. *Chronic Diffuse Labyrinthitis.*—This condition has

no characteristic symptoms. There is no spontaneous nystagmus, no vertigo or disturbances of equilibrium. The condition is discovered during a routine examination of the ear. The patient is totally deaf on the diseased side. The caloric test is negative. If the case is of long duration and compensation has been established, the rotation shows equal after-nystagmus after rotation in both directions. If the case is a recent one, while nystagmus can be obtained after rotation to right and to left, the after-nystagmus toward the diseased side may be shorter than the nystagmus toward the sound side.

3. *Paralabyrinthitis with Fistula.*—This condition usually follows chronic purulent otitis media, especially the cholesteatomatous cases. Cholesteatoma causes an erosion of some parts of the labyrinthine capsule. The process is a slow one, "and permits of the walling off by adhesions at the point of exposure of the perilymphatic space." The commonest location for an erosion is in the external semicircular canal, as it lies in the aditus. The next most common site is near the foramen ovale, and the least common is on the promontory.

The symptoms are not continuous, but come at intervals and are due to irritation of the exposed labyrinth, external conditions causing changes in the intra-labyrinthine pressure. They consist of vertigo, disturbances of equilibrium and spontaneous nystagmus. They vary only in intensity and frequency from those that mark the onset of any diffuse inflammation of the labyrinth. Hearing tests show a middle-ear lesion. The fistula test is positive. Rae says "Should we on compression obtain some coarse nystagmic movements, or a conjugate movement of the eyes in one direction, and should we obtain on aspiration a conjugate deviation of the eyes in the opposite direction, a diagnosis of labyrinthine fistula may be made."

The caloric reactions are easily obtained because of the exposure of the labyrinth. The turning test shows a normal after-nystagmus in either direction.

4. *Paralabyrinthitis without Fistula.*—In these cases the symptoms are as those described above, but the fistula test is negative.

Treatment.—The treatment of labyrinthitis may be divided into medical and surgical.

1. Medical treatment consists in absolute rest in bed, free catharsis, soft diet and sedatives if necessary.
2. The surgical treatment consists in the opening of the vestibule, cochlea, and semicircular canals with or without exposure, and opening of the dura of the posterior and middle cranial fossæ.

It must be remembered that treatment at the present time can do nothing toward the prevention of loss of function (hearing etc.), but it simply is to prevent intracranial complications. Labyrinthitis *per se* is never fatal, and it is only when the disease spreads toward the meninges that it becomes dangerous. Formerly aural surgeons, especially those of the Vienna school, were much more radical in operating upon the labyrinth, but now it is realized that an operation upon a diseased labyrinth is in itself a somewhat dangerous procedure, because the surgeon, by his operative trauma, may break down the barrier that separates the infection from the meninges and cause a spread of the process to these structures and accomplish exactly the dangers the operation was intended to avoid.

In acute diffuse labyrinthitis no operation is performed unless meningeal involvement seems imminent or is present.

Temperature over 100° (if not explained by the causal condition), headache, photophobia, exaggerated reflexes and a positive Kernig, together with characteristic changes in the cerebrospinal fluid, are indications of meningitis.

There are certain cases of acute labyrinthitis in which an antecedent condition (such as an acute mastoid) demands operation. In these cases the labyrinth is not opened at the time of the mastoid operation unless changes in the spinal fluid, taken and examined at that time, show beginning meningeal involvement.

In chronic diffuse labyrinthitis accompanying a chronic suppurating ear, no radical operation should be performed unless the surgeon is prepared to open the labyrinth at the same time, in case a definite fistula is found leading into the labyrinth. In cases of very long standing, where compensation is apparently established and where no fistula is found, it is deemed safe by some not to open the labyrinth.

In cases of beginning or suspected meningitis an operation of the Neumann type is indicated, together with opening of the dura in the region of the internal auditory meatus and middle fossa.

In the chronic cases, without meningeal involvement, an operation of the Hinsberg type is indicated, *i. e.*, opening the vestibule, semicircular canals and cochlea without exposure of the dura.

In paralabyrinthitis a radical operation only is indicated, the fistula is not curetted, and its lumen is left undisturbed as much as possible.

In the acute cases operate only for impending meningitis. In the chronic cases open the labyrinth only where there is reason to believe it contains a suppurating focus.

In paralabyrinthitis do only a radical operation, leaving the fistula undisturbed.

OPERATIONS UPON THE LABYRINTH.

1. **The Hinsberg Operation.**—The vestibule is opened at its outer wall, above and below the facial canal. The canals are left untouched except that portion of the external canal which must be removed in order to reach the vestibule. The bridge between the foramen ovale and foramen rotundum is removed, and the cochlea drained by removing the promontory.

2. **The Neumann Operation.**—This operation necessitates exposure of the cerebellar dura. The bone over Trautmann's triangle is first removed: this is the space bounded by the cerebral dura above, the petrous pyramid in front, and the sinus behind. When this is removed the dura is separated carefully from the posterior surface of the petrous pyramid. The petrous pyramid is then removed until the posterior canal is opened. Two small openings are then seen. With further removal of the pyramid a third opening appears, viz., the posterior end of the external semicircular canal. This opening leads directly into the vestibule which may then be widely opened. The bone to the

inner side of the opening into the vestibule is removed until the internal auditory meatus is exposed. The

FIG. 196.

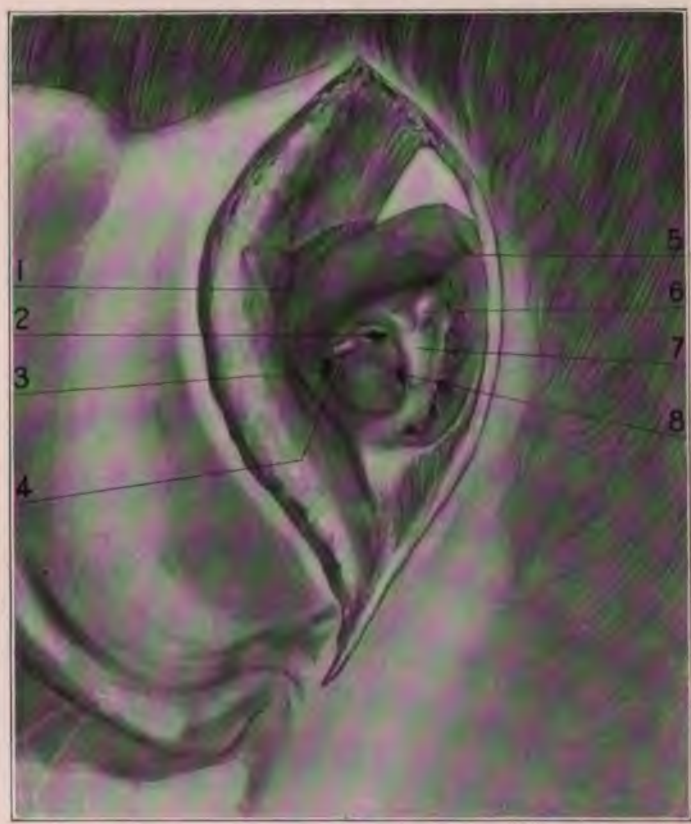
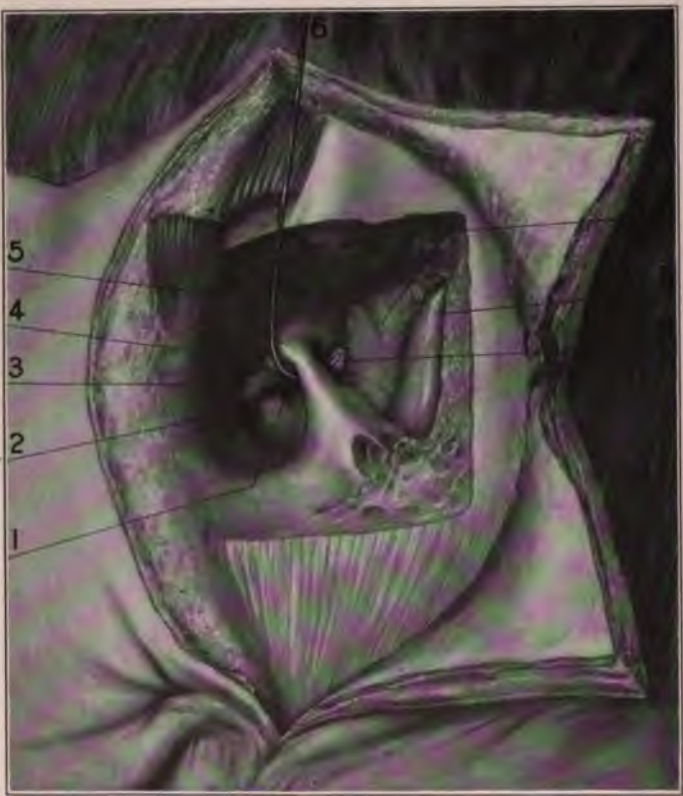


Illustration shows a radical mastoid operation which has been performed preparatory to opening the vestibule and semicircular canals. 1, aqueductus Fallopii; 2, foramen ovale; 3, Eustachian tube; 4, bony canal for tensor; 5, external semicircular canal; 6, posterior semicircular canal; 7, facial ridge (posterior canal wall); 8, foramen rotundum. (From an original dissection by T. L. Saunders, M.D.)

bridge between the oval and round windows is removed and the cochlea drained by removing the promontory.

Fig. 197.



An operation of the Neumann type has been performed. The probe is seen passing underneath the facial ridge into the opened vestibule. 1, opened cochlea; 2, Eustachian tube; 3, canal for tensor tympani; 4, horizontal portion of aqueductus Fallopii; 5, external semicircular canal; 6, probe passing into the joined openings of the foramina ovale and rotundum; 7, cerebellar dura; 8, sigmoid sinus; 9, opened vestibule (below this is seen the dura of the internal auditory meatus). (Drawn from an original dissection by T. L. Saunders, M.D.)

The mastoid wound should be drained posteriorly until the bone is well covered with granulations.

FIG. 198.

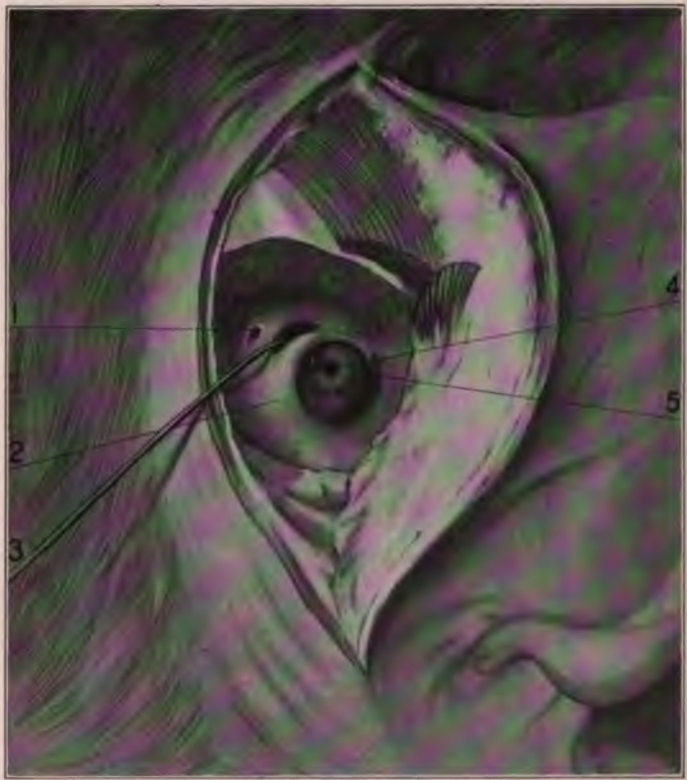


Illustration showing an operation of the Hinsberg type. The vestibule has been opened above and below the facial canal. The cochlea has been opened over the promontory. 1, posterior semicircular canal; 2, facial canal; 3, probe passing into the open vestibule; 4, opening into cochlea; 5, opening of Eustachian tube. (From an original dissection by T. L. Saunders, M.D.)

NEUROÖTOLOGY.

The Bárány tests are of great value in the diagnosis of lesions in the brain-stem (medulla and pons), cerebellum and cerebrum. We are indebted to Randall, Jones and Fisher,[1] of the University of Pennsylvania, for improvements in the technic of the tests, which have greatly increased their efficiency as diagnostic aids.

"An intelligent interpretation of the phenomena obtained by such tests (caloric turning, past-pointing) can give the examiner an insight into the condition of various brain paths and brain centres in relation with the internal ear. Thus when a known stimulus is applied to the labyrinth, any response obtained therefrom, be it nystagmus or vertigo, indicates not only a functionating and a reacting labyrinth, but also intact pathways from the labyrinth to the brain centres responsible for these reactions. Conversely, the non-appearance of any of the normal responses to stimulation indicates an interruption at some point along the particular pathway that fails to produce the particular response."

These writers have shown that the fibres from the horizontal semicircular canal have an entirely separate course in the brain-stem from those of the vertical canals, and while they all go to the cerebellum, those from the horizontal canal reach it by way of the inferior cerebellar peduncle, while those from the vertical canals go by way of the middle cerebellar peduncle.

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[1] The author has drawn freely from the article of Jones and Fisher, Annals of Otology, vol. xxvi, No. 1.

They are also convinced that nystagmus and vertigo are distinct and separate phenomena and that past-pointing is a cerebral phenomenon exclusively, and depends on the vertigo induced by the ear stimulation.

While one cannot consider in this book the diagnosis of brain conditions other than those directly caused by suppurative conditions of the ear, on account of the growing importance of the subject and because of the value of the tests themselves in the physical examination of candidates for military aviation service, it seems advisable to give the technic of the examination in full.

A complete record of the patient is essential and the following chart adopted from Jones is used:

NAME .... **DATE** ....
ADDRESS .... **AGE** ....
REFERRED BY ....
DIAGNOSIS ....
....
....
SUMMARY ....
....
....
....
COMPLAINS OF ....
....
HISTORY
Dizziness ....
Staggering ....
Deafness ....
Tinnitus ....
NOSE ....
....
THROAT ....
....
A. D. ....
EARS ....
A. S. ....
FISTULA ....
HEARING TESTS ....

A	A	c^4	Ac Ae	Bc Bc	n n	Galt.	Pol.

TESTS OF THE VESTIBULAR APPARATUS.

NYSTAGMUS.		POINTING. Right.	Left.
	SPONTANEOUS.		
Looking to right	Shoulder from above		
	" " below		
Looking to left	" " side		
	Nystagmus		
	Vertigo		
	Past-pointing		
	Falling		
	Romberg		
	Turning head to right		
	Turning head to left		
	Attempt to overthrow		
	Goniometer		
	TURNING.		
To right Amp. Duration sec.	To right Shoulder from above	to	to
	Nystagmus		
	Vertigo		
	Past-pointing		
	Falling		
To left Amp. Duration sec.	To left Shoulder from above	to	to
	Nystagmus		
	Vertigo		
	Past-pointing		
	Falling		
	CALORIC.		
Douche right Amp. After min. sec.	Douche right Shoulder from above	to	to
	Nystagmus		
	Vertigo		
	Past-pointing		
	Falling		
Douche left Amp. After min. sec.	Douche left Shoulder from above	to	to
	Nystagmus		
	Vertigo		
	Past-pointing		
	Falling		

Spontaneous Nystagmus.—When the surgeon observes this symptom the patient is directed to look ahead at some distant point (convergence may limit or efface nystagmus). Any spontaneous nystagmus when the patient looks straight ahead is pathologic. A certain amount of nystagmus may be present when the patient looks to the extreme right or left. It is only pathologic when it is of considerable amplitude or when there is a sharp difference between nystagmus on looking to the right and to the left. To observe vertical nystagmus the eyelids are held wide apart, and the patient is told to look directly upward and then downward. Spontaneous vertical nystagmus is of intracranial origin and is pathognomonic of involvement of the brain stem.

Spontaneous Vertigo.—The patient is asked if he has any sensation of turning? Is it systematized? *i. e.:*

1. Does the patient feel that he is going in a certain direction, or
2. Are his surroundings moving around him in a certain direction, but he is standing still, or
3. Is he moving in one direction and his surroundings in another?

Spontaneous Pointing.—The patient sits in the chair and is told to put his arm forward and point with his forefinger. The examiner holds out his own forefinger and allows that of the patient to come in contact with his. The examiner steadies his arm against his own body and further steadies his outstretched forefinger by means of the other hand. The patient's forefinger is allowed to come in contact with the examiner's finger, after which the patient raises his arm without bending the elbow, to the perpendicular position, and immediately brings it back to touch the examiner's finger. He is then directed to repeat this with his eyes closed. A normal patient should be able to do this. Should he deviate in past-pointing to the right or left, the distance is recorded in inches. Repeat the test several times to be sure that it is not the result of inattention. Care must be taken not to allow the patient to make a conscious correction of this condition. Usually this testing of the shoulder-joint is sufficient.

Spontaneous Falling.—*The Romberg Test.*—The patient is told to stand with heels and toes together and eyes closed. His attitude is noted. While in this position the patient's head is quickly turned to the right and the effect on his attitude or on his tendency to fall is, if present, noted. In a like manner the head is turned to the left.

In intracranial lesions patients always fall in the same direction.

In labyrinthine lesions falling is influenced by the direction of the head.

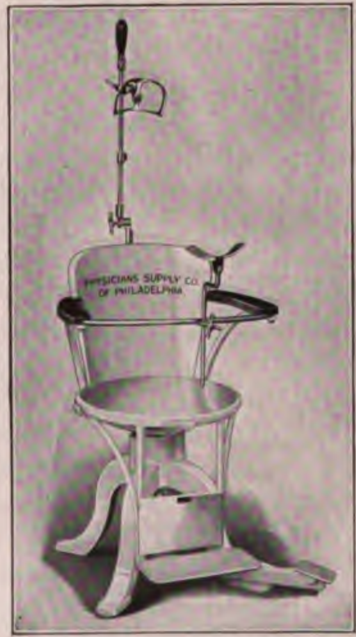
The Attempt to Overthrow.—The patient stands as before and the examiner grasps the patient at both shoulders and attempts to overthrow him either to the right or left, or forward or backward, instructing the patient to resist by a balancing movement at the hips. When the shoulders of the patient are moved toward the right, the pelvis should sway toward the left. On pushing the patient backward, the pelvis should move forward, etc. A normal individual balances perfectly and can lean in any of the former directions, considerably before falling.

In a patient with an affection of the vermis of the cerebellum, the pelvis fails to compensate and the patient falls at the slightest touch.

Turning Tests.—A chair with a good head-rest and stop-pedal must be used (Fig. 199). The surgeon tests for nystagmus, then for vertigo and then for past-pointing. The horizontal canals are tested and the head must be tilted 30 degrees forward and held there by the head-rest.

Nystagmus after Turning.—During the turning the patient's eyes are closed. The chair is rotated to the right ten times in twenty seconds. The patient is then told to open his eyes and look at a distance. The after-turning nystagmus is noted, its direction, character and duration. The duration is best taken with a stop-watch from the time the chair stops to the last nystagmus twitch. The amplitude is noted, large, small, fair or barely a twitch. Duration of normal nystagmus

Fig. 199.



American modification of Bárány chair.

thus noted should be about twenty-six seconds. In a similar manner the patient is turned to the left. Greatly shortened after-nystagmus denotes either an affection of the labyrinth or if that is normal, a defective vestibulo-oculo-motor tract.

Vertigo after Turning.—It may be tested quantitatively. The plane of the induced vertigo is always in the plane of the canal stimulated and in a direction opposite to the endolymph movement. With the patient seated as before, with eyes closed (to test the horizontal canals) he is turned to the right at a uniform rate of speed, ten turns in ten seconds, and is asked to keep telling the examiner in what direction he is being turned. Thus he keeps saying "to the right," "to the right." When the chair is stopped he will say "I am going to the left." The time is noted from when the chair is stopped until the patient says "I am standing still." Normally it is twenty-four seconds. The test is repeated by turning to the left. As the past-pointing depends on the sense of vertigo, the quantitative vertigo test is not employed since the presence of past-pointing is indicative of the presence of vertigo.

Past-pointing after Turning.—The patient's head is fixed so that the horizontal canals only are tested and the chair turned at double the rate of speed as for nystagmus, that is, ten turns in ten seconds. The patient is carefully instructed as to what is expected of him and is told to keep his eyes closed during the entire test. The examiner stands in front of the patient with the pedal near his right foot. As the chair is turned for the tenth time the speed of the chair is gradually slackened and the stop accomplished without jarring.

The patient's right hand is quickly grasped and after his forefinger touches the examiner's finger, the examiner says "up" upon which the patient raises his arm to the perpendicular and immediately tries to come down on the examiner's finger. The past-pointing is noted in inches. The left arm is immediately tested in the same way and then the right arm again and so on until there is no longer any past-pointing. The patient is then similarly tested by turning to the left.

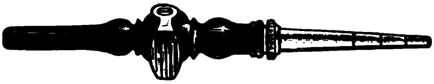
Should it be desired to test the vertical canals the patient must be placed either 120 degrees forward or 60 degrees backward. In taking the past-pointing with the head forward, the examiner must kneel before the patient. In a normal individual turning to the right always causes past-pointing to the right, turning to the left past-pointing to the left.

In a normal individual turning to the right with head inclined 30 degrees or 120 degrees forward causes nystagmus to left. With head 60 degrees backward it causes nystagmus to the right. Past-pointing after turning indicates an intact labyrinth and an intact vestibulo-cerebello-cerebral tract.

Falling after Turning. Falling tests are seldom necessary in routine examination. Falling after turning results only when the patient has a sensation of turning in a vertical plane. A patient with head 30 degrees forward has no falling after rotation, because he feels he is revolving in a plane parallel to the floor. After turning with the head forward or backward, if the patient's head be brought to the upright position, the patient feels that he is rotating in a plane at right angles to the floor and falls to the right or left.

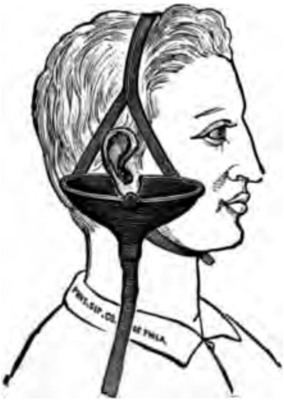
The Caloric Test. Water at 68° F. is employed. The time from the onset of douching to the onset of the nystagmus is noted. The douching is continued for a few seconds after the nystagmus appears, to obtain the maximum reaction. The nystagmus is rotatory and with the head 30 degrees forward the vertical canals only are tested.

FIG. 200.



Nozzle with closing valve.

FIG. 201.



Rubber receptacle to catch return flow of water in the caloric test.

The past-pointing tests are now carried out. Then the patient's head is quickly inclined backward and the horizontal canal may be tested.

The electric current is now but little employed in the testing of the vestibular apparatus.

Ear Tests Required by the United States Government for Candidates for the Aviation Service. In examining candidates for the aviation service, the "ear tests" are extremely important. By them only can we determine whether the candidate possesses a perfect balance mechanism. The aviator must be in fine physical condition. He must have 20/20 vision and 40/40 hearing.

The following are the official tests required by the United States Aviation Service at the present time:

1. The nystagmus,[1] past-pointing, and falling after turning are tested. The turning-chair must have a head-rest which will hold the head 30 degrees forward, a foot-rest and a stop-pedal. (The American Modification of the Bárâny chair is officially required. While the tests could be made by using other types of turning-chair, an exact quantitative estimation of the responses can be definitely established only by the use of a standardized chair.)

(*a*) *Nystagmus.* First of all, a spontaneous nystagmus must be looked for. It is noted whether there is any twitching of the eyes when gazing straight ahead, or looking either to the extreme right, the extreme left, up or down. With the head forward 30 degrees, the candidate is turned to the right, eyes closed, ten turns in twenty seconds. The instant the chair is stopped, the stop-watch is clicked; the candidate opens his eyes and looks straight ahead at some distant point. There should occur a horizontal nystagmus to the left of twenty-six seconds' duration. A variation of ten seconds is allowable (either as low as sixteen seconds, or as high as thirty-six seconds). In a similar manner the candidate is turned to the left and the nystagmus noted.

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[1] Jones, American Medical Association, vol. lxix, No. 19.

(*b*) *Past-pointing.* 1. The candidate closes his eyes, sitting in a chair facing the examiner, touches the examiner's finger held in front of him, raises his arm to the perpendicular position, lowers the arm, and attempts to find the examiner's finger. This is done first with the right and then with the left arm. The normal person is always able to find the finger.

2. The pointing test is repeated after turning to the right, ten turns in ten seconds. During the last turn the stop-pedal is released, and as the chair comes into position it becomes locked. The right arm is tested, then the left, then the right, then the left, until candidate ceases to past-point. The absolutely normal will past-point to the right three times with each arm, if needless delay is avoided. (However, one past-pointing to the right of each arm qualifies, if the nystagmus and falling are normal.)

3. The past-pointing is repeated after turning to the left. (Similarly one past-pointing of each arm to the left qualifies, if the nystagmus and falling are normal.)

(*c*) *Falling.* The candidate's head is inclined 90 degrees forward. He is turned to the right five turns in ten seconds. On stopping, the candidate quietly sits up, eyes closed, and should fall to the right. This tests the vertical semicircular canals. He is turned to the left, the head forward 90 degrees; on stopping, he again sits up, and should fall to the left.

The majority of candidates show normal responses. In doubtful cases, the caloric test is made, and the reaction noted. If a candidate is found deficient in his vestibular mechanism, he is rejected.

PYÆMIA.

Septicæmia and pyæmia are complications that are liable to occur in connection with suppurative otitis media whenever septic material is absorbed, whether in disease of the middle ear, antrum, or mastoid cells, or in thrombosis of one of the sinuses or of the internal jugular vein. In cases of perforation of the mastoid tip, in which the pus makes its way beneath the deep fascia, unless evacuated at once there is great danger that absorption will take place and give rise to blood-poisoning. If septic particles are carried into the circulation from a disorganized clot, infarctions occur in the lungs as well as other organs, and fatal pyæmia is usually the result. This fact demonstrates the importance of always removing every source of infection whenever the mastoid antrum or cells are involved. Some writers, notably Koerner, believe that metastatic pyæmia may develop from osteophlebitis alone without involvement of the sinus. On the other hand, Jansen states that in sixty-three cases of pyæmia he failed only four times to prove the presence of sinus thrombosis. He further believes that in all cases of pyæmia in which the sinus appears healthy, particularly when following an acute otitis, one should think of a phlebitis of the bulb. Some authorities advocate the internal administration of creosote and bichloride of mercury, but such treatment is usually of little avail. Pyæmia is not always fatal, for in a case[1] of acute purulent otitis media following mastoid disease which came under my care, not only were the lungs affected, but collections of pus were also found in different parts of the body. The case was that of a man, aged twenty-three years, who had an acute attack of earache followed by a profuse discharge. He developed mastoid disease, but disappeared from observation for several days. He returned, and complained of nausea, vertigo, and chilly sensations. The mastoid cells were opened immediately, and found filled with pus. He subsequently had chills, high temperature with sudden remissions, sweating, and became much emaciated. He eventually recovered. The case was one in which the pus, after breaking through the mastoid tip (Bezold perforation), burrowed beneath the deep fascia in the neck.

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[1] Bacon: Trans. of the Am. Otol. Soc., 1885, vol. iii, part iv.

CHAPTER XIII.

DISEASES OF THE SOUND-PERCEIVING APPARATUS.

DISEASES of the sound-perceiving apparatus are classified usually as primary or secondary affections, the former being met with much less frequently than the latter. According to the earlier writers, many cases were called "nerve deafness" which should have been classified as affections of the middle ear, but in the light of our present information there are comparatively few cases of primary disease of the internal ear. Affections of the internal ear may develop idiopathically or be due to severe cold, blows, falls, sunstroke, or to malarial fever, typhus and typhoid, scarlatina, syphilis, measles, diphtheria, influenza, leucocythæmia, Bright's disease, diabetes, mumps, and locomotor ataxia. Chemical changes in the blood of patients suffering from general diseases produce disturbances in the auditory centres or in the expansion of the auditory nerve in the labyrinth. Secondary changes take place in the labyrinth from inflammation of the middle ear, but it should not be forgotten that the same cause may produce affections of the middle ear as well as of the labyrinth and the auditory nerve, or that the sound-perceiving and the sound-conducting apparatus may simultaneously be involved. This is especially the case in those insidious forms of adhesive catarrh which lead to anchylosis of the stapes. In cases of acute inflammation of the middle ear, owing to the anastomosis between the vessels of the tympanum and labyrinth, the latter may become congested, and, as a result, ecchymoses and serous infiltration of the membranous labyrinth may follow, with increase of the intralabyrinthine pressure. When this occurs, the patient may complain of deafness, giddiness, vertigo, nausea, vomiting, tinnitus; and the ability to hear the tuning-fork. by bone-conduction may be impaired or even lost. In some cases there is hyperæsthesia of the auditory nerve. In diphtheritic affections the labyrinth may become involved from the entrance of micro-organisms, and in chronic purulent otitis media followed by caries and necrosis the internal ear is liable to be involved. Pathogenic micro-organisms, the streptococcus, the staphylococcus, and the diplococcus of pneumonia, or other germs may invade the labyrinth from the cranial cavity by means of the aquæductus vestibuli and aquæductus cochleæ. In consequence of such invasion there is liable to be a rapid destruction of the connective tissue, or there may be a new growth of connective tissue and bloodvessels leading to bone formation, or the micro-organisms may cause thrombo-arteritis and phlebitis. The auditory nerve is affected more frequently by general disease than the other nerves of special sense; and certain drugs, such as quinine and salicylic acid, as well as the excessive use of tobacco, may give rise to subjective noises, and to deafness if used in large doses or continuously.

In certain diseases of the brain and spinal cord, especially epidemic cerebro-spinal meningitis, and in consequence of cerebral tumors, disturbances of hearing are due to pressure on the internal auditory nerve or to the extension of inflammatory products from the cranial cavity to the labyrinth and auditory nerve trunk. It is the opinion of many writers that in cases of cerebro-spinal meningitis the poison enters the nose, and that the ears may be the tract through which the microbe travels to the brain. According to G. Royet, the pneumococcus is found frequently in the cephalo-rachidian fluid and less frequently the meningococcus of Weichselbaum and the other bacteria. The cerebro-spinal fluid is always opalescent at first, then purulent and greenish. Increased leucocytosis is well-marked with an increase also of the polynuclear elements. In affections of the brain and medulla the nuclei and roots of the auditory nerve may be involved, and as a result deafness follows. Disturbances of hearing are observed at times in diseases of the liver, kidney, uterus, stomach, and also in anæmia and marasmus. Other causes of internal-ear disease are aneurism of proximate blood-vessels and malignant growths beginning in the temporal bone. Fracture at the base of the skull may produce temporary or permanent deafness, with or without hemorrhage from the ear, followed by a serous discharge. Artillerymen and boilermakers are especially liable to nerve deafness, on account of the loud sounds to which they are constantly exposed.

Progressive disease affecting the auditory nerve trunk is seldom confined permanently to one ear, for sooner or later the other ear is likely to be involved. As the root-fibres of the auditory nerve on one side extend into the external auditory nucleus on the other, degenerative processes of one internal auditory nerve may attack the centre and stem of the nerve on the opposite side.

In some affections of the internal ear the deafness comes on very suddenly. Especially is this the case in cerebro-spinal meningitis, syphilis, Ménière's disease, as well as in consequence of falls and blows. In addition to giddiness, deafness, vomiting, and loss of hearing by bone-conduction, the patient often complains of disturbances of equilibration, which are at times so marked, as in Ménière's disease, that the patient is unable to stand without support. Beside the causes already mentioned, it is undoubtedly a fact that hereditary influences play an important rôle, and also that a sudden mental disturbance, such as fright, may give rise to an affection of the internal ear through a sudden disturbance of the circulation of the labyrinth.

Children are more frequently the subjects of disease of the internal ear than adults, for the reasons probably (1) that they are more prone to the exanthematous diseases and cerebro-spinal meningitis, and (2) in children the communications between the cranial cavity and the middle and inner ears, and also between the tympanum and labyrinth, are more direct than in adults, so that inflammatory products are more liable to be carried from the cranial cavity and the middle ear to the labyrinth. Very young children, or the aged, are more frequently the subjects of labyrinthine disease than those of middle age.

In diseases of the auditory nerve the hearing is not so subject to marked fluctuations as in middle-ear disease. If the deafness due to a nerve lesion does not become more marked, it is likely to remain about the same from day to day, although impaired health, bodily fatigue, and worry, as well as over-indulgence in the use of tobacco and alcohol, tend to aggravate the disease.

Prognosis. The prognosis is, as a rule, unfavorable, although very much depends on the causation, the intensity, and the duration of the disease. In recent syphilitic disease much can be accomplished by general constitutional treatment and by the hypodermic injection of pilocarpine, and undoubtedly in many cases in which there is serous and possibly small-celled infiltration permanent restoration of hearing may follow. The administration of salvarsan should also be considered in these cases. On the other hand, it is proved by clinical observation that deafness often remains after extensive effusion of blood has taken place in the labyrinth, with the invasion of the various cocci, and especially where there is extensive caries or necrosis of the temporal bone. In order to make a differential diagnosis between middle-ear and internal-ear affections, it may be stated, as a general rule, that—

1. In diseases of the inner ear, low-toned tuning-forks are heard better than the higher ones by aërial conduction, if any fork is heard at all; while in disease of the middle ear, if the nerve is not affected, the reverse is true—*i. e.*, the higher forks are heard better.

2. In disease affecting the labyrinth or internal auditory nerve, the bone-conduction becomes impaired or lost, as shown by Rinné's, Weber's, or Schwabach's test (see chapter on Examination of the Ear). In the case of a person with normal hearing, a vibrating tuning-fork should be placed on the mastoid process, and the surgeon should be notified by a signal from the patient when he ceases to hear the sound. If the fork is then held close to the meatus, it will be heard for several seconds longer. In middle-ear or external-ear diseases the tuning-fork will be heard much longer when placed on the mastoid than when held close to the meatus. In a case of deafness in which the labyrinth is involved,

the bone-conduction becomes more impaired or lost altogether. Notes of a low pitch are, as a rule, heard better than high ones by air-conduction. In consequence, the watch is not heard as well as the voice.

Other important instruments for testing the hearing are the acoumeter, the Galton whistle, and König's rods. When the acoumeter is not heard by bone-conduction, there is a reasonable certainty that the internal ear is affected. It should not be forgotten, however, that frequently diminished bone-conduction is observed in cases of adhesive catarrh of the middle ear as a result of secondary implication of the internal ear or of intra-labyrinthine pressure, and to physiological conditions in persons over sixty years of age.

If a patient presents himself suffering from deafness of recent origin, and if an examination shows that the drumhead is normal and the Eustachian tube pervious, it is probable that the case is one of disease of the auditory nerve. It is often difficult for the surgeon to differentiate between a middle-ear affection, in which there are symptoms of vertigo, dizziness, and tinnitus, and an affection of the brain itself. The same symptoms observed in labyrinthine disease may occur in disease of the central nervous system. In the latter there will be such other symptoms as choked disk, paralyses, loss of sensation of one or both sides of the body, and diminished or increased tendon reflexes.

HYPERÆMIA OF THE LABYRINTH.

Hyperæmia of the labyrinth is likely to occur in a severe case of acute purulent otitis media, especially if due to scarlatina, diphtheria, or other acute exanthematous diseases. It is observed also in cases of tumor of the brain in which there is an obstruction to the escape of blood from the inner ear, and in patients suffering from other general diseases, such as typhoid or typhus fever, cerebro-spinal meningitis, and in cerebral congestion accompanying diseases of the lungs or heart. It follows the administration of certain drugs, such as nitrite of amyl, quinine, and salicylic acid. Hence great caution should be observed in administering this class of drugs to patients suffering from deafness from any cause. Unless the hyperæmia is of a temporary character, there may be pigment exudations in the labyrinth or the membranous labyrinth may become thickened. The symptoms in the acute stage of hyperæmia are vertigo, giddiness, vomiting, inabilty to walk steadily, tinnitus, and a sensation of fulness about the ears. Very often it will be noticed, on examination of the ear, that there is a slight congestion of the vessels along the handle of the malleus and of the bony canal adjoining the drumhead.

It is very difficult to make a differential diagnosis between hyperæmia of the labyrinth and of the brain centre, owing to similarity of the symptoms. The treatment depends altogether on the cause. The patient should be kept quiet and put on a simple and wholesome diet. If occurring in connection with congestion of the brain, cold applications should be applied to the head. Small doses of calomel, to produce watery evacuations, are also useful. When the drumhead is injected simultaneously, the local abstraction of blood from the ante-auricular and mastoid regions is indicated, as well as the application of the Leiter coil.

ANÆMIA OF THE LABYRINTH.

This affection is observed in cases of general anæmia and chlorosis after great loss of blood, or there may be some obstruction to the blood-supply of the labyrinth, due to the pressure of a tumor, an aneurism, or there may be atheromatous changes, etc. In a case of loss of blood, followed by anæmia of the labyrinth, the symptoms are deafness, distressing tinnitus, faintness, vertigo, nausea, and vomiting.

As to treatment, this should be directed to the cause. When the disease is chronic, iron should be given, while a change of air is often advisable.

HEMORRHAGE INTO THE LABYRINTH.

Slight extravasations of blood occur in the labyrinth as a result of disease or of fracture at the base of the skull, or such extravasations may be due to concussion of the skull or to extensive necrosis of the temporal bone. When due to disease, the walls of the vessels may be weakened by atheromatous changes or by intense hyperæmia during the course of scarlet fever, diphtheria, mumps, smallpox, pernicious anæmia, diabetes, and other diseases.

INCREASED PRESSURE OF THE LABYRINTHINE FLUID FROM DISEASE OF THE TYMPANUM.

As already mentioned, vertigo and disturbances of equilibration are prominent symptoms of labyrinthine disease. In cases, however, of middle-ear disease, or those in which a plug of cerumen presses against the drumhead so that the foot-plate of the stapes is forced inward and the pressure of the labyrinthine fluid is increased, the patient often complains of more or less vertigo. The membrane of the foramen rotundum should, under normal conditions, by bulging outward compensate for the pressure exerted upon the foot-plate of the stapes. It is possible to explain the occurrence of the vertigo as being due to unusual pressure from the labyrinthine fluid on account of congestion of the blood-vessels or to the fact that the membrane covering the foramen rotundum does not bulge outward, owing to thickening having occurred from catarrhal changes.

A patient came under my care a short time since who complained of severe vertigo. He was unable to leave his room for several days on account of the severity of the attack. The history was that he had had a plug of inspissated cerumen removed from the ear by syringing a few days previously, and that since then he had been troubled with severe dizziness. He was a man of fine appearance and in excellent health. An examination was made of the urine, heart, lungs, etc., as well as of the fundus of the eyes. Nothing was found to explain the vertigo except the condition of the ear, there being slight retraction of the drumhead and catarrhal changes. Inflation by Politzer's method daily for several days effected a cure. In syringing the ear at times the patient will complain of sudden vertigo, and occasionally fall from the chair, owing to faintness. Such a phenomenon is undoubtedly due to sudden pressure exerted on the foot-plate of the stapes.

Aural vertigo is induced occasionally by the presence of a polypus which is attached in the neighborhood of the stapes. When this occurs, the patient often complains of a sense of fulness in the ear, with a distinct subjective circulatory tinnitus. The vertigo may be so severe that the patient is unable to maintain an erect position. The removal of such a polypoid growth should be performed most carefully, as the necessary manipulation is likely to cause increased vertigo and accompanying nausea.

OTITIS INTERNA, OR INFLAMMATION OF THE LABYRINTH.

Inflammation of the lining membrane of the bony labyrinth, as well as of the membranous labyrinth may be either *primary* or *secondary*, the former being extremely infrequent. The secondary form, as a rule, follows inflammation of the middle ear, and is liable to occur as a result of diphtheria, scarlatina, tuberculosis, or extensive caries and necrosis of the temporal bone. In such cases the labyrinth may be filled with pus, while the walls of the membranous labyrinth become thickened and ecchymosed.

Chronic inflammation of the labyrinth, though extremely infrequent, does occur, and, as a result, there is an increase of connective tissue with hyperostosis and calcareous deposits. The saccule and ampullæ become thickened, and finally there may follow atrophy of the membranous labyrinth and disappearance of the organ of Corti.

It is extremely difficult to make a diagnosis of acute inflammation of the labyrinth, for the symptoms, which generally are noticed in children are similar to those observed in meningitis followed by recovery, except that in the former the disease comes on suddenly, and the more serious symptoms last for about a week. The child is apt to have fever, more or less congestion of the face, vomiting, delirium, deafness, vertigo, convulsions, and coma.

MÉNIÈRE'S DISEASE.

Ménière's disease is an affection of the semicircular canals, even extending into the vestibule. It was first described by Ménière, of Paris, as being due to an effusion of blood or an acute exudation into the semicircular canals. Many cases of aural vertigo, which are due to the presence of a plug of cerumen in the external meatus or to disease of the middle ear, give rise to symptoms of this disease and are classified erroneously as Ménière's disease. The name of Ménière's disease, however, should be limited to those cases in which there is a sudden effusion of blood into the semicircular canal, followed by deafness, giddiness, distressing tinnitus, vertigo, a staggering gait, nausea, and vomiting. The patient may have premonitory symptoms, such as those already mentioned, or may fall suddenly to the ground from loss of consciousness, which is followed in a short time by excessive pallor of the face, cold perspiration, extreme deafness and tinnitus, with an inclination to vomit and more or less vertigo on trying to walk. The disease is not confined to those who are in poor health, but it may attack strong and healthy individuals who previously had not suffered from ear disease. Occasionally, a patient may have premonitory symptoms, such as slight dizziness, tinnitus, and some deafness, before the more serious symptoms manifest themselves.

The cause of the disease is obscure, some observers attributing it to excessive heat of the sun. The deafness is usually very marked, so that the patient can hear only very loud sounds close to the ear. The watch or acoumeter cannot be heard by contact. Bone-conduction, as shown by tests with the tuning-fork, is very much impaired or lost altogether. If an examination of the ear is made at the time, the drumhead will usually be found normal, as well as the Eustachian tube. Even after the patient has recovered from the vomiting and the unconsciousness, the giddiness and staggering gait may persist and be slow in disappearing, so that it may be some time before the patient can walk without a cane, and he is apt to incline his body to the affected side in walking. The disturbance of hearing generally remains, although there may be some improvement, while the tinnitus is often most distressing. The milder attacks of this disease are mistaken sometimes for biliousness, but a careful consideration of the symptoms already mentioned should make the differential diagnosis comparatively easy. Ménière's disease is sometimes suggestive of disease of the brain. In the latter, however, there are generally symptoms denoting paralysis of spinal or cerebral nerves, but it should not be forgotten that giddiness, vomiting, nausea, and tinnitus are symptoms characteristic of brain affections. I have referred to a case of chronic purulent otitis media (in the chapter on Intracranial Affections), in which the patient had all the symptoms of a cerebellar abscess—giddiness, vomiting, a staggering gait and choked disk—but who finally recovered after proper drainage of the middle ears had been established by scraping away all granulations from the tympanic cavity. A positive diagnosis can only be made of Ménière's disease if the surgeon knows that the patient, before the attack, had normal hearing, and, further, that an examination of the ear made a short time afterward shows the Eustachian tube to be pervious and the drumhead normal.

Prognosis. In cases of long standing the prognosis as to the deafness is unfavorable, and it is only in recent cases that one can hope for even a little improvement.

Treatment. The treatment should consist in the use of cold compresses to the head and the application of the Leiter coil about the ear. Calomel in small doses should be given to produce slight catharsis. Sinapisms should be applied to the back of the neck and the calves of the legs. The patient should be kept absolutely quiet in bed and given a very light diet. Some observers recommend iodide of potash, while others, particularly Charcot, have found much benefit from the administration of quinine in rather large doses. Bromide of potash, and dilute hydrobromic acid in fifteen-drop doses, are of service in relieving the giddiness.

The best results seem to be attained from the injection of five or six drops of a 2 per cent. solution of pilocarpine through the catheter into the tympanum, or from the hypodermic injection of the same remedy and in the same strength. This treatment should be continued for a period of at least four weeks, and injections should be made hypodermically or the solution should be used through the catheter every other day during this time. The surgeon should be very cautious with this drug, and should follow the directions already given (see Chapter VIII.).

Electricity is of but little service in this disease, and should never be used in the early stage for fear of increasing the tinnitus and giddiness. Especial attention should be paid to the patient's general health, particularly if there is a gouty or rheumatic diathesis.

Tonics are indicated in cases where the general condition demands them.

Many cases of supposed aural vertigo are referred to the otologist by the general practitioner, and it is very difficult at times to make a diagnosis. The patient is apt to be neurasthenic and to have a chronic catarrhal otitis media, with a diminution or absence of bone-conduction, affecting one or both ears. There is also, as a rule, a distressing tinnitus. Vestibular vertigo is said never to occur without nystagmus. Increased pressure of the labyrinthine fluid may cause vertigo in certain middle-ear diseases. Vertigo may be due to pressure on the vestibular nerve, to lesions of the cerebellum, to ocular diseases, to diseases of the pons and medulla. Other causes of vertigo are migraine, changes in the blood-pressure, uræmia, intestinal toxæmia, gout, diabetes, syphilis, arterio-sclerosis, diseases of the liver, the action of certain drugs, and other diseases.

Shambaugh[1] says it is "quite impossible to separate a distinct group of cases and assert that these alone were the result of hemorrhage into the labyrinth, and that all the other cases of primary disease of the labyrinth presenting symptoms of attacks of vertigo with tinnitus and disturbed hearing were not caused by hemorrhage.

"For these reasons many writers have given up the use of the term 'Ménière's disease' for any of these cases, even for those in which it seems certain that a hemorrhage into the labyrinth has given rise to this syndrome, as, for example, when these symptoms occur in cases of pernicious anemia. The term

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[1] Journal American Medical Association, September 8, 1917.

'Ménière syndrome' has, however, come into general use to designate attacks of vertigo when associated with tinnitus and deafness, irrespective of the cause, whether it be from disease of the labyrinth secondary to middle-ear infection or to meningitis, or to disease occurring primarily in the labyrinth, or whether it is occasioned by intracranial disease causing disturbance of the central tract of the eighth nerve. This term is an appropriate one by which to designate a characteristic group of symptoms, especially since it serves to perpetuate in otologic literature the name of the physician whose contribution represented a distinct epoch in otology.

"Vertigo is now recognized to be as distinctly an aural symptom as is tinnitus, and when present indicates a disturbance of the vestibular nerve, either in its peripheral distribution in the semicircular canals or in its central pathways in the brain."

He draws the following conclusions:

"1. Primary disease of the labyrinth produces attacks of vertigo whenever the vestibular apparatus is involved by an acute process.

"2. Hemorrhage into the labyrinth is much less common than was formerly supposed.

"3. An embolus lodging in the labyrinthine artery occurs especially in caisson workers, as the result of gas emboli, and gives rise to the characteristic Ménière syndrome.

"4. Syphilis in the secondary and tertiary stages, as well as in hereditary syphilis, not infrequently involves the internal ear and gives rise to vertigo.

"5. Neuritis of the eighth nerve from overdoses of drugs, such as quinine, tobacco and alcohol, may produce neuritis of the eighth nerve with the Ménière syndrome.

"6. Toxic neuritis of the eighth nerve as the result of infectious fevers frequently gives rise to attacks of vertigo.

"7. The most frequent occurrence of vertigo is in connection with a primary chronic degenerative process involving the peripheral neurons of the eighth nerve and occurring independent of syphilis or the infectious fevers.

"8. The probable cause for many of these cases is to be found in a neuritis of the eighth nerve, as the result of some chronic focus of infection, such as is so frequently seen in chronic disease of the faucial tonsil.

"9. Attacks of vertigo occurring in connection with acute articular rheumatism are the result of neuritis of the eighth nerve and a symptom of the systemic infection from some primary focus."

Dundas Grant[1] has recently given, with much benefit, doses of ¼ to ½ grain of quinine to patients suffering from aural vertigo, and he has found that in a large proportion of them relief was speedily attained. He considers that the quinine acts as a sedative to the vestibular apparatus. Dilute hydrobromic acid alone, or combined with quinine, is also recommended. Lake has seen much benefit follow the use of ernutine.

In cases of non-suppurative labyrinthitis, when the patients are almost crazed by the severe vertigo and tinnitus, and all medicinal treatment has been tried in vain, the question of dividing the internal auditory nerve at its entrance to the internal auditory meatus or of destroying the labyrinth, especially the cochlea, is sometimes considered. A few successful cases have been reported of dividing the nerve, but in most cases the results have been fatal or have failed to relieve the distressing symptoms. The ablation of the cochlea is accomplished, after first performing a radical mastoid operation, in order to expose the promontory. The outer wall of the promontory is removed with a narrow gouge so as to expose the modiolus. The latter is cut away and the cavity gently curetted. Cerebro-spinal fluid escapes which can be controlled. According to statistics published, the results from this operation are much more favorable than those following division of the auditory nerve. To relieve severe attacks of vertigo, partial or total ablation of the semicircular canals has been performed successfully. The dangers of these operations should be fully explained to patients before attempting them.

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[1] Transactions Ninth International Otological Congress, Boston, Mass., August 12, 1912.

Some patients suffering from severe attacks of vertigo and with incessant and distressing tinnitus attempt suicide, and in such instances, at least, it becomes necessary to do something of a radical nature.

Babinski has reported eight cases of disease of the labyrinth with Ménière's symptoms which were treated with benefit by lumbar puncture and the tinnitus was improved. He believes that lumbar puncture has a remarkable influence on aural vertigo, and that it also has a favorable influence on tinnitus and deafness, but to a less noticeable extent. It is more efficacious generally in pure labyrinthine lesions, according to Babinski, than in mixed lesions of the ear, and more so in cicatricial cases of chronic catarrhal otitis media than in the sclerosed cases. He does not think there is any danger in its employment.

Milligan has tried operative measures in three cases of so-called Ménière's disease where the patient suffered from vertigo for years, incessant noises, and progressive deafness. He first performed the radical operation, followed by exposure of the horizontal semicircular canal to the origin of the superior one. The same was done to the posterior canal. Then the horizontal canal was removed with curettage of the cavity and removal of all the soft parts. In two cases the vertigo disappeared and the patients resumed their occupations. There was complete destruction of hearing and slight improvement in the tinnitus.

Richard Lake has reported a case in which he removed a portion of the cochlea, the external wall of the vestibule, and the external semicircular canal for the relief of tinnitus and vertigo. The patient was a girl, aged twenty-six years, who was troubled with intolerable noises and vertigo with a tendency to fall forward. There was complete deafness. Five days after the operation the patient could, with closed eyes, stand up or turn around, and even pick up an object on the floor.

Lake[1] has since reported other cases of aural vertigo in which he operated successfully. The operation which he performs is vestibulotomy, and consists in opening the vestibule and destroying its contents. He says, "I prefer opening the vestibule both above and below the facial nerve for the greater certainty of efficient curettage of its cavity." Lake feels that one is justified in operating if internal medication has failed to afford relief and the patient's existence is unbearable. He says "that where the cochlear division of the eighth nerve is relatively intact, no operation should be considered. Vertigo of other than aural origin is usually accompanied by at least fairly good hearing." Lake[1] in a subsequent paper says that, according to his investigations, chronic progressive middle-ear deafness and arterio-sclerosis are the most frequent causes of aural vertigo.

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[1] Ten cases of operation for Ménière's disease (aural vertigo). The Lancet, June 10, 1911.

MUMPS.

Although disease of the middle ear may occur as a complication of mumps, as shown by the usual appearances of inflammation of the drum membrane, there are a certain number of cases in which the labyrinth is involved either primarily or secondarily. As a rule, only one ear is implicated when the disease affects the labyrinth. The diagnosis is made from the occurrence of sudden deafness with impairment or loss of bone-conduction, as shown by tests made with tuning-forks. Tinnitus is also a troublesome symptom at times. Much can be accomplished by the use of hypodermic injections of pilocarpine if the case is seen at an early date. As a rule, however, these patients do not come to the aural surgeon for treatment until the deafness has existed for a long time. The application of a blister behind the ear is of benefit in some cases.

SYPHILIS.

Syphilis affecting the labyrinth does not generally develop during the secondary stage when the skin is covered by an eruption or there is a throat affection, but is more likely to be observed during the third stage or even several months or years after the first inoculation, when no signs of syphilis can be discovered on the body. Some writers, however, believe that syphilis does affect the eighth nerve in an early stage of the disease, and that the following symptoms should make one suspicious; viz., a strongly positive Rinné test, with the air conduction unimpaired, especially for low tones; bone conduction much diminished or even lost. These symptoms may occur in the primary or secondary stages of syphilis and may also be found in the hereditary form. Habermann and Rigaud, on the other hand, give statistics to show that about 50 per cent. of the cases of syphilis of the ear occur in the secondary stage. There may be a middle-ear catarrh or purulent inflammation at the same time. In many cases of syphilitic ear disease great thickening of the drumhead takes place, and fibrous bands are found within the tympanic cavity. In recent cases it is possible that there is a plastic exudation in the labyrinth, but this is not certain. In a later stage the following abnormal appearances have been found, viz., condensation of the periosteum of the vestibule, fixation of the foot-plate of the stapes, and great infiltration of the different portions of the membranous labyrinth. The deafness, as a rule, comes on very suddenly, and is attended with considerable tinnitus. Pain is not usually complained of, but there are frequently more or less vertigo and disturbances of equilibration. An examination may show that the Eustachian tube is involved, particularly if there are throat symptoms. Frequently the drumhead is found very much retracted, opaque, and thickened. The deafness is in most cases profound, and is more likely to effect both ears than one ear alone. As the disease generally affects the labyrinth or eighth nerve, the watch and acoumeter are frequently not heard at all. While tests with tuning-forks show a very much diminished or even absent bone-conduction, low tones are heard much better by aërial conduction than high ones.

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[1] Aural vertigo (non-suppurative). The Lancet, December 14, 1912.

Diagnosis. A diagnosis is difficult in many cases unless there is a syphilitic history or there are evidences of the disease in other parts of the body, particularly the eyes or the teeth. The suddenness of the attack is a suspicious symptom ; but it should not be forgotten that the deafness may come on gradually.

Hereditary syphilis is, I believe, much more frequent in children than is generally supposed. There may be middle-ear disease at the same time that the labyrinth is involved. Other symptoms characteristic of syphilis are opacity of the cornea from interstitial keratitis, and peculiar changes in the teeth, Hutchinson's "pegged teeth," so called. Autopsies made in the case of new-born children who were syphilitic have revealed more or less suppurative otitis media, with thickening of the drumhead and adhesions. There was more or less pus in the vestibule, the organ of Corti was destroyed, while the labyrinth was hyperæmic and contained effusions of blood.

WASSERMANN'S TEST. Wassermann's[1] test and that of von Pirquet are of material assistance in reaching a diagnosis in obscure cases. The technique is complicated and demands the skill only to be acquired by the careful laboratory worker.

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[1] For a concise description of this test and some of its modifications the reader is referred to Immune Sera, by Dr. C. F. Bolduan, John Wiley & Sons, New York, 1908.

Prognosis. The prognosis is, as a general rule, unfavorable, especially in the case of congenital syphilis and when the disease has existed for quite a period of time. It is only in the recent cases that one can hope for much improvement; and even in such, very often, there is but little change for the better. This does not mean that there should not be carried out a prompt and energetic treatment which should be kept up for some time.

Treatment. The treatment depends very much as to whether there is any manifestation of the disease in other parts of the body. In some cases it is advisable to use mercury in addition to the iodide of potash. In prescribing the former, I generally advise inunctions behind the ear over the mastoid process. The best results will generally be obtained from hypodermic injections of a 2 per cent. pilocarpine solution, gradually increasing the dose from four or six drops until the patient experiences the physiological effect of the drug. Great care should be taken in its administration on account of its depressing action.

As to the effect of salvarsan on the eighth or internal auditory nerve opinions differ. Alexander, in the course of six years at the Polyclinic and General Hospital at Vienna, saw but six cases of syphilis affecting the ear, and only two of these had internal ear symptoms. Since, however, the introduction of salvarsan in the treatment of syphilis, there have been observed in Vienna many more cases of ear disease, and Alexander believes that the involvement of the auditory nerve is due to the toxic effect of the remedy, and he recommends that this drug be administered with great caution in cases in which there is or has been any acute syphilitic disease of the internal auditory nerve.

On the other hand, Benario, of Frankfort-on-Main, Dujardin, of Brussels, and others believe that the ill effects are due to an insufficient dosage of salvarsan, which should, in all cases, be given by intravenous injection. In addition to a large dose at first, there should be given a second one in three or four weeks. In the meantime treatment by mercury should be vigorously carried out.

Further investigations will have to be carried out before one can be certain of the effect of salvarsan on the internal auditory nerve.

BOILERMAKERS' DEAFNESS.

The deafness observed in the case of boilermakers, who are subject to the incessant hammering inside of boilers, is due to an affection of the labyrinth. It has been suggested that there may be some loosening of the articulating joints of the ossicula from the excessive vibrations, but from all the cases that have come under my observation, tests made with tuning-forks have demonstrated the fact that there was impaired bone-conduction, showing that the disturbance of hearing and tinnitus were not due primarily to middle-ear inflammation, although in these patients one frequently finds evidence of catarrhal changes in the membrana tympani.

There is very little that can be done in the way of treatment. If the disease is not far advanced, a change of occupation may occasion considerable improvement in the hearing.

ACTION OF CERTAIN DRUGS.

The use of certain drugs, such as quinine and salicylic acid, continued for a long time and in large doses, undoubtedly causes disturbances of hearing and tinnitus, that may in some cases be permanent. It is supposed by some that the action of quinine upon the ear is similar to the effect produced on the retina, viz., anæmia. The common practice of "aborting a cold" by the administration of large doses of quinine is, in my opinion, an exceedingly bad one, and much injury to the hearing has been brought about by such treatment, especially in those who inherit a tendency to deafness and who are sufferers from more or less middle-ear inflammation.

Wittmaack[1] in his experiments on animals claims to demonstrate that the only action of quinine is on the nerve cells of the ganglion of Corti and that it does not cause any vascular disturbance in the labyrinth. The action of salicylate of soda is very similar to that of quinine. Haike,[2] following experiments by Wittmaack, has made investigations as to salicylic acid and aspirin. Agreeing with Wittmaack he found anatomic changes in the ganglion cells of the vestibular ganglion as well as in the spiral ganglion, which affected principally the Nissl bodies. In the auditory tract a degeneration of the medullated sheaths could be demonstrated.

Arsenic has an effect on the mucous membrane of the middle ear, for cases of serous otitis media have been reported which did not yield to treatment until the patients had ceased taking arsenic.

Tobacco, according to Delie[3] has a direct action on the acoustic nerve. It attacks both ears at a time, and according to this author it is especially advisable that those suffering from deafness due to sclerosis should abstain as far as possible from its use.

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[1] Zeitschr. f. Ohrenh., Bd. xlvi, Heft 1 u. 2.

[2] Arch. f. Ohrenh., vol. lxiii, p. 78.

[3] Rev. Heb. de Laryngol. d'Otol., January 28, 1905.

DEAFNESS DUE TO OLD AGE.

After middle life the ability to hear the notes of a Galton whistle or of the König rods becomes lessened, so that in testing the hearing-power of persons of advancing years one must make allowance for the age of the patient. The otologist is frequently consulted by very old patients who complain of inability to hear conversation, although otherwise they enjoy excellent health. Upon making an examination of the drumhead it will very likely be found thickened, retracted, and opaque, and in some cases atrophic, with evidences of implication of the labyrinth and auditory nerve. Very little encouragement should be given to such patients, for the prognosis is usually unfavorable.

There may, however, be another cause for the impaired hearing, namely, *collapse of the cartilaginous meatus*, so that the anterior and posterior walls touch each other and leave but little space for the entrance of sound-waves. I have improved the hearing of such patients by introducing small silver tubes especially constructed for this purpose.

DISEASES AFFECTING THE AUDITORY NERVE.

Diseases affecting this nerve are, as a rule, due to secondary causes, such as meningitis, cerebro-spinal meningitis, aneurism of the basilar artery, when there is likely to be more or less congestion of the neurilemma of the nerve. In purulent meningitis, and when there are extensive caries and necrosis of the temporal bone, the nerve is likely to be inflamed and infiltrated.

Atrophy of the auditory nerve results from diseases of the brain and cerebellum, and occurs in certain cases in which tumors of the brain press upon the nerve, the latter disappearing altogether in some instances; also from affections of the spinal cord, especially locomotor ataxia.

Bruhl[1] has demonstrated microscopic specimens of the cochlea of a patient, aged forty-four years, who lost his hearing in the course of tabes. Corti's organ and the termination of the vestibular nerve did not show any marked changes. The spiral ganglion and the trunk of the auditory nerve presented distinct changes, which could be followed into the medulla oblongata. According to the grade of the anatomical changes, it can be assumed that the process of degeneration started from the spiral ganglion.

NEW-GROWTHS AFFECTING THE INNER EAR.

New-growths affecting the labyrinth and auditory nerve generally have their origin in the cranial cavity or the middle ear. Cases have, however, been reported of primary sarcoma and of neuroma of the auditory nerve. The new-growths that are observed most frequently in the external meatus and tympanum which involve the petrous bone and inner ear are epitheliomata and sarcomata.

HYPERÆSTHESIA ACUSTICA.

Occasionally in neurasthenic or highly nervous individuals, or those recovering from a long illness, certain sounds give rise to painful sensations in the ear. This same phenomenon is observed also in certain forms of sclerosis of the middle ear and in acute and chronic diseases of the middle ear and labyrinth. It is a curious fact that such patients are often extremely deaf.

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[1] German Otological Society, Archives of Otology, vol. xxxiv, No. 6.

CHAPTER XIV.

DEAF-MUTISM.

DEAF-MUTISM may be congenital or acquired—*e. g.*, due to some disease affecting the ear soon after birth. Heredity is one of the most frequent causes, as well as consanguineous marriages. In many instances of congenital deaf-mutism the cause is traceable to some forefather, although occasionally children are born deaf who present no hereditary history whatever.

Acquired deaf-mutism is usually due to some intracranial or general disease, such as meningitis, hydrocephalus, cerebro-spinal meningitis, injuries of the auditory nerve from falls or blows, scarlatina, measles, typhus and typhoid fevers, diphtheria, mumps, inflammation of the labyrinth, and syphilis. Scarlet fever in children is the most frequent cause of permanent deafness and deaf-mutism. According to the statistics of May, in five thousand six hundred and thirteen cases of deaf-mutism, five hundred and seventy-two were due to scarlet fever. It is occasionally impossible to tell whether a case of deaf-mutism in an infant is congenital or acquired, for until the child is a year old the defect in hearing is not noticed, so that the parents often believe that the child had good hearing up to a certain age, but that the deafness came on suddenly. Of one thousand and seventy-six cases of deaf-mutism reported by Macleod Yearsley,[1] four hundred and eighty-four, or

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[1] Transactions Ninth International Otological Congress, Boston, Mass., Aug. 12, 1912.

44.98 per cent., were born deaf, and five hundred and ninety-two, or 55.0 per cent., acquired their defect.

Of four hundred and seventy-nine deaf-born cases, no family history could be obtained in one hundred and forty-eight. In one hundred and eighty-six there was no family history of congenital deafness, and in the remaining one hundred and forty-five other examples of deaf-birth occurred. The second group, viz., one hundred and eighty-six cases "showed chiefly as possible etiological factors, illegitimacy, insanity, chronic alcoholism, and the presence in the family of such other defectives as mental deficients, imbeciles, physical deficients, and epilepsy. There were also eight instances of cousin marriage." He further says, "that it is an established fact that, in investigating the part played by heredity in deaf-birth, the collateral family tree is of equal or even greater importance than the direct ancestry." Besides consanguinity, alcohol, and insanity as factors, Yearsley believes that congenital syphilis is a potent cause of acquired educational deafness in children, but very little is known as to its influence upon deaf-birth. He believes it probable that certain cases of congenital deafness may be due to syphilis.

Of five hundred and ninety-two acquired cases of deafness, reported by the same writer, 26.3 per cent. owed their origin to the exanthemata, and 21.9 per cent. were due to preventable middle-ear disease. The writer of this paper concludes by saying: "Not only do otologists require to be awakened to a realization of their duties to the deaf child, but general practitioners educated to that sense. If marriages of the deaf-born and of blood relations and the union of alcoholics, syphilitics, and those with a family taint of insanity could be prohibited, these restrictions would be of great assistance."

Anatomical investigations show that congenital deafness is due to some arrest or defect in development of the temporal bone, such as bilaterial atresia of the external auditory canal, imperfect development or absence of the tympanic cavity, defects in or bony closure of the fenestra rotunda, anchylosis of the stapes, and arrest of development of the labyrinth or auditory nerve. Alexander[1] of Vienna has reported on the microscopic examination of the ear of a deaf-mute. In addition to other changes there were bilateral atrophy (hypoplasia) of the eighth nerve in the trunk and branches, and of all of the ganglia, atrophy of the static nerve, of the terminals of Corti's organs, and bilateral arrest of development of the capsules of the cochlea.

In acquired deaf-mutism, the principal anatomical changes are constriction of the external auditory canals of both sides occurring in early life, which usually is due to a severe attack of diphtheria or scarlatina in which there has been a purulent inflammation of the middle ear, followed by extensive caries and necrosis of the temporal bone. Other causes are the formation of adhesions with anchylosis of the ossicula and certain changes in the labyrinth and auditory nerve from the general diseases already mentioned. A baby brought to my observation a short time ago, although he had learned to say a few words, had gradually lost all power of speech and hearing. On closely questioning the mother, it was ascertained that the child had had a fall from a baby carriage some months previously. In a case of acquired deaf-mutism reported by Schwabach,[2] following an attack of cerebro-spinal meningitis in the seventh year, there was found complete obliteration of the cochlea, with newly-formed bone tissue on both sides and a peculiar new formation in the vestibule, also bilateral. This consisted principally in a convolution of medullated nerve fibres, presenting the picture which Virchow has described as an amputation-neuroma.

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[1] Archives of Otology, Dec., 1904.

[2] Archives of Otology, Dec., 1904.

Children are, as a rule, apt to be dumb if the deafness comes on during the first three or four years of life, and even later. If the child is bright and intelligent, and has already learned to read, dumbness may be prevented if the parent or guardian shows very watchful attention.

Children who lose their hearing after seven years of age are scarcely ever dumb. In testing the hearing of a child that is deaf and dumb the surgeon should stand behind the child, where he cannot be observed, and then either clap his hands or blow a shrill whistle or trumpet. If the child hears any sound whatever, he will naturally turn his head in the direction from which it comes. By some expression of the face the child will often demonstrate to the surgeon whether he hears low or high tuning-forks when they are placed on the mastoid process and portions of the skull. If it seems certain that some perception of sound exists, the surgeon should test each ear separately to see if the patient hears vowel sounds and speech.

Deaf-mutes without hearing are not affected by rotation. The best-hearing deaf-mutes show generally rotating vertigo.

Prognosis. As to the prognosis, it is more favorable in congenital deaf-mutism than in the acquired form. Occasionally, but very infrequently, improvement occurs in the case of congenital deaf-mutism, while in profound deafness which has followed an attack of scarlet fever, diphtheria, or intracranial disease, a change for the better is seldom observed.

Treatment. If, in a case of deaf-mutism, the drumheads are retracted, thickened, and present other changes of a catarrhal character, or the Eustachian tubes are constricted so that air does not readily enter the tympanic cavities, the surgeon should inflate the ears by Politzer's method or by catheterization, while the same general treatment should be carried out as has been indicated in the chapter on Chronic Catarrhal Otitis Media. If the external auditory canals have become very much contracted from suppurative inflammation of the middle ear, which has been due to scarlet fever or diphtheria, an attempt should be made to dilate the canal and to treat the case on general surgical principles according to the indications.

When the labyrinth has become involved, owing to cerebro-spinal meningitis or some other disease, the patient should be given strychnine or other nerve tonics, and strict attention should be paid to the patient's general health. Iodide of potash is indicated in some cases, especially of a syphilitic character. Pilocarpine is a remedy that should be tried if the patient's general health is good, and the deafness has been acquired and is due to labyrinthine disease. It is most important to administer this drug very cautiously, on account of its depressing action on the heart; and when given, it should be continued if possible for a period of at least six weeks. In a case[1] of extreme deafness in an adult, caused by typhoid fever, in which the patient was unable to hear the voice through a speaking-trumpet with one ear, it was necessary to give pilocarpine hypodermically for a period of six weeks before any marked improvement took place. It is wiser to discontinue the treatment for a few days should the patient become very weak.

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[1] Bacon: New York Medical Journal, July 24, 1897.

INSTRUCTION AND EDUCATION OF DEAF-MUTES.

There are two methods or systems by which deaf-mutes are educated, one the so-called French system of instruction, consisting in an artificial finger-alphabet, with a series of signs and gestures, and the other the pure oral or German method, which consists in the employment of articulate speech and lip-reading. At the International Congress held at Milan in 1880 it was the unanimous opinion that the German method was the better one, and at the present time lip-reading or speech-reading is generally taught not only in Europe, but also in the United States, to the exclusion of the sign language.

The German method necessitates great skill and patience on the part of both teacher and pupil. In order to become proficient in lip-reading, it is first of all necessary that the child possess ordinary intelligence and normal vocal organs. A child who is a congenital deaf-mute should be at least seven years of age before such instruction is begun, and, in order to be able to understand and communicate perfectly with others, this teaching should be continued for seven or eight years.

Some deaf-mutes are taught to speak very distinctly, while with others it is almost impossible to understand what they say. As it is difficult for deaf-mutes to modulate the voice, there is often an unpleasant harshness of speech.

The French system is employed occasionally in the case of deaf-mutes who are deficient in intelligence and who cannot master the oral method. It is often impossible to teach lip-reading to those who have been deaf for many years, and who are accustomed to using signs.

When a child has suddenly become deaf from some general disease, such as scarlet fever or diphtheria, it is important for the patient himself to read aloud for an hour or two each day in order not to lose the art of speech. For all who have recently become deaf, and who cannot be cured by treatment, whether children or adults, an attempt should be made at once to teach lip-reading, provided, of course, the child is old enough. When speech has once been acquired, it is much easier to instruct the patient than when the deafness is congenital.

The German method, or the science of lip-, speech-, or expression-reading, consists in teaching deaf-mutes to watch the lips and tongue, as well as to produce first of all the simple articulate sounds, and eventually the more complex ones.

After being instructed in all the sounds necessary to the language, the pupil is then taught how to form words, and the meaning of such words is conveyed to the child by means of pictures, models, etc. The use of signs should be prohibited, for otherwise the pupil will not be apt to master the German method, since the former is much easier to learn than the latter and requires much less patience and perseverance on the part of the patient. The general education of the child should be carried on at the same time. An intelligent and observing pupil soon learns to notice not only the movement of the lips, but also the position of the tongue, the general shape of the mouth, and the facial expression. He also watches the brow expression, the twinkle in the eye, and the involuntary movement of the head.

Prof. Denker[1] has reported that "in the Bavarian Senate, it was voted that, owing to the favorable results obtained for a number of years in Munich by separate instruction, deaf-mutes are to be collected in separate classes and instructed by a method in which the eye and ear are equally employed; and it would seem desirable that, in the various institutions for deaf-mute children, separate divisions should be formed for those with auditory remnants."

Many persons of a neurasthenic temperament, and who are quite deaf, owing to chronic catarrhal otitis media, and who consequently are unable to take part in general conversation, occasionally become morose and despondent. These unfortunate patients, after receiving instruction in lip-reading or speech-reading, are often enabled to resume business and to become again useful members of society, while the feeling of despondency and isolation gives place to renewed interests and ambitions.

EAR-TRUMPETS AND OTHER AIDS TO HEARING.

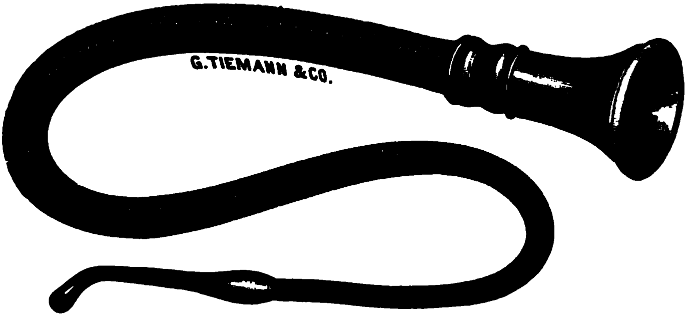
Ear-trumpets are of service in certain forms of deafness, more especially when due to chronic catarrh of the middle ear, in which the drumhead and ossicular chain are present. In those cases in which the labyrinth is affected and the function of the auditory nerve is destroyed completely, an ear-trumpet is generally useless. As the object of the hearing-instrument is to collect the sound-waves and conduct them to the auditory apparatus, it stands to reason that the efficiency of the

[1] Archives of Otology, December, 1904.

instrument depends on the surface by which the sound-waves are collected and reflected to the drumhead.

When two persons desire to carry on a conversation, the best instrument for this purpose is the "conversation-tube" (Fig. 202), consisting of a tube about four feet in length, with a bone tip at one end for insertion into the external meatus, while at the other end there is a mouth-piece, shaped like a cup. In talking into the mouth-piece the person speaking should hold the mouth close to it, and should at first speak in an ordinary tone of voice, for loud sounds spoken through the tube are sometimes distressing to the patient and cause giddiness.

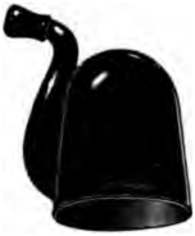
FIG. 202.


G.TIEMANN &CO.

Conversation-tube.

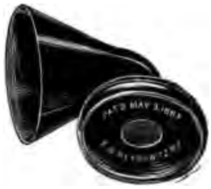
For the purpose of hearing at great distances various trumpet-shaped instruments have been devised (Fig. 203). As the external meatus occasionally becomes irritated from inserting the conical end in the canal, an otophone has been constructed (Fig. 204) whereby this annoyance is prevented. The sound-waves in this instrument are transmitted through a rubber disk which is stretched tightly. Very small trumpets are useless, as well as the various tubes which are introduced into the canal. There is an exception to this rule, and that is in the case of a collapsed meatus, a subject already referred to. In aged persons the walls of the meatus sometimes collapse, so that it is difficult for the sound-waves to be transmitted to the drumhead. In such cases a silver tube is useful in holding the walls of the meatus apart. Rhodes's audiphone consists of a flexible fan-shaped plate of vulcanite which has been lacquered, and which has a handle attached. By pressing the upper border of the instrument against the upper incisor and canine teeth, a curved surface is presented, with the

FIG. 203.



Ear-trumpet.

FIG. 204.



Otophone.

convexity forward. The sound-waves are collected by the audiphone and carried through the teeth and bones of the skull to the internal ear. This instrument has a very limited use, and is never recommended unless the patient has a good set of teeth.

Politzer has devised an instrument the "principle of which depends upon the vibration of the cartilaginous plate of the auricle being transmitted by an elastic sound-conductor to the membrana tympani." It consists of a narrow drainage-tube, 4 to 5 mm. long and 2 mm. thick; one end, which is clipped, being brought into contact with the drumhead, while the other end, which lies in the concha, is in contact with the cartilage of the auricle. The effectiveness is increased by having a round rubber plate near its outer end. The instrument is of most benefit in cases of middle-ear catarrh when the membrana tympani is flaccid, but is useless in cases of rigidity and anchylosis of the ossicula.

The acousticon and similar electrical instruments, which are practically "portable telephones," are of great service to some extremely deaf patients, while others cannot use them at all.

APPENDIX.

METHOD OF PREPARING SMEARS.

All preparations of pus for the purpose of bacteriological examination should be as thin as possible. The best method is to cleanse thoroughly two medium thick new cover glasses, obtain and place in the centre of one a drop of pus, place the other cover over it, compress the two between the thumb and forefinger of the left hand sufficiently to secure a uniformly thin layer of the secretion, remove the surplus around the edges with a small piece of filter paper, gauze or other material which can be destroyed, slide one cover over the other until the edge of one projects beyond the edge of its companion, then grasp the upper cover between the thumb and forefinger of the right hand, grasp the under cover in a similar manner with the left hand, and continue the sliding movement until the covers are completely separated. They should then be laid down, prepared surface up, and allowed to dry in the air. When thoroughly dry they are ready for the bacteriologist.

If a drop of pus cannot be obtained, the next best method is to secure the specimen desired by means of cotton wound on the end of a cotton carrier or tooth pick, and then smear it over the surface of the covers or clean new slides as thinly and evenly as possible and allow them to dry as above.

CULTIVATIONS.

Almost any antiseptic, including boric acid, will inhibit the growth of germs ; consequently considerable care must be used in making cultivations from the canal or tympanum. If the canal has been irrigated with an antiseptic solution, and a cultivation is desired, the canal should be irrigated carefully with warm sterile water, the meatus then being closed with cotton, and allowed to remain undisturbed for several hours, The cotton is then to be removed, the canal thoroughly cleansed with dry sterile cotton, and the pus for the cultivation removed from the tympanum, or blown through the perforation by the patient, who has been directed to blow his nose. If this fails on account of the tube being closed, the pus can be drawn through by exhausting the air in the canal with the Delstanche masseur. The next step is to make the inoculation. The surgeon should have two culture tubes, one of solid media such as blood serum or agar, and the other of bouillon, and two sterile cotton-tipped wire rods such as are supplied by the Boards of Health for diphtheria cultivations. A separate rod should be used for each tube.

If the case "has not perforated" the method of procedure will differ slightly provided it is desirable to make the cultivation at the time of the paracentesis. In this event, the canal should be sterilized, then irrigated with warm sterile water, and thoroughly dried with sterile dry cotton. An assistant should hold the cotton-tipped sterile rod in a position to enable him to hand it to the operator quickly without contamination, so that the moment paracentesis has been done the operator can obtain a specimen of pus escaping from the tympanum before hemorrhage has obscured the field of operation. The utmost care is necessary to insure success, as Dixon states that failure has frequently resulted from mopping out the canal with alcoholic bichloride previous to paracentesis, and making cultivations as much as an hour after irrigations with so mild an antiseptic as boric acid.

It is seldom possible to demonstrate the presence of the Klebs-Löffler, or the tubercle bacillus in secretions from the ear without cultivation in the case of the former, and the physiological experiment in the case of the latter.

PHYSIOLOGICAL INOCULATION EXPERIMENT.

The inoculation experiment will frequently fail though we are morally certain that tuberculosis exists.

Failing to demonstrate the presence of the tubercle bacillus by means of cover-glass preparations of the pus, the physiological experiment is to be undertaken as follows: Prepare the canal as above, have ready a healthy rabbit with a cocainized eye, and instruments as follows, *sterilized by boiling;* one pair of smooth flat fine-pointed forceps, a pair of fine-pointed ear scissors, and a set of ear specula, for the purpose of removing suspicious tissue, and a fine flat-pointed, rubber-tipped pipette or dropper for the purpose of removing pus for the inoculation, and for the rabbit a pair of fixation forceps and a keratome. Ocular specula are generally too large to be used on the eye of a rabbit; therefore the lids will have to be separated by an assistant. The rabbit can be held by a second assistant who will grasp the ears with one hand, the hind legs with the other, and stretch the animal which will then be helpless, or its body and legs can be confined in a large towel when one assistant can hold the animal by the ears with one hand and separate the lids with the other. The operator having obtained the tissue or pus required will make as small an incision as will admit the material through the cornea into the anterior chamber. This incision is best made at the upper limbus and the tissue or pus should be deposited in the anterior chamber as low down as possible while firmly holding the globe with the fixation forceps, otherwise the animal will subsequently be able to remove the offending material through the corneal wound by rubbing his eye, or the iris may force it out by retraction, if it be left near the wound. The animal is then to be penned without dressing. During the next twenty-four to thirty-six hours there is generally violent reaction. This will soon subside, and the eye may become almost normal, but about the beginning of the third week, if the material was tubercular, either a tubercular iritis or panophthalmitis will become apparent. The eye should not be removed for examination before the end of the third week, and a negative report should not be given before the end of the fourth or fifth week.

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